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Photograph by E. Muller.

Length, 465 feet 9 inches. **Beam,** 60 feet 1 inch. **Depth of hold,** 31 feet. **Displacement,** 12,585 tons. **Speed,** 16 knots. **Carrying capacity,** 6,410 tons of coal.

LAUNCH OF THE UNITED STATES NAVAL COLLIER "VESTAL."

LAUNCH OF THE COLLIER "VESTAL."

A NEW EXPERIMENT BY OUR NAVY.

THERE was successfully launched at the Brooklyn navy yard on May 19 the first of our naval colliers to be built specially for the service of the navy. The list of naval colliers shows a miscellaneous group of vessels, built, with two exceptions, in England and Scotland, and ranging in displacement from a little over 3,000 tons to 9,250 tons. They are credited with speeds of from 8½ to 11 knots an hour. The two exceptions mentioned above are the "Vestal," recently launched at Brooklyn, and the "Prometheus," now under construction at the navy yard, Mare Island, California. They are sister ships, and both are being built by the United States government.

The "Vestal," which was laid down about a year and a half ago, has been built upon the same ways as the battleship "Connecticut," and under the same supervision of Capt. W. J. Baxter, the chief naval constructor at the Brooklyn yard, who is to be congratulated upon the excellent job done on the vessel, and upon the success with which the launch was carried through. The "Vestal" is a steel vessel with four pole masts. She is 465 feet 9 inches in length over all, and measures 450 feet between perpendiculars. She has a breadth of 60 feet 1 inch, a depth of hold of 34 feet, and a mean draft when loaded of 26 feet. She is driven by twin-screw, vertical, triple-expansion engines of 7,500 horse-power at a speed, when loaded, of 16 knots an hour. She carries a maximum amount of 1,576 tons in her bunkers for her own use, and she can stow from 5,600 to 6,410 tons of coal in her hold for the needs of the navy. She has a complement of 13 officers and 163 men, and carries a light armament of four 3-inch rapid-fire guns. She will be manned by officers and sailors of the navy, and not, as is the case with the other colliers of the fleet, by masters and crews of the merchant marine. It should be mentioned that the displacement of the ship is 12,585 tons.

At a few minutes before 11 o'clock the sandbags were cut, and as the sand poured out, the vessel sank upon the well-greased ways, down which she was to make her trip to the water. The last step was to saw through the "sole beams," which are the last members that connect the launching ways with the permanent ways, and the instant they were cut, the "Vestal" was appropriately named by Miss Goodrich, the daughter of the commandant of the Brooklyn navy yard.

In this connection it is gratifying to the officials and workmen of the Brooklyn navy yard to know that the government has given orders that one of the new 20,000-ton "Dreadnoughts" authorized by the present Congress be built at the yard. The ship will be constructed upon the same slip as the "Vestal" and the "Connecticut."

THE UNITED STATES NAVAL COLLIER "VESTAL" IMMEDIATELY AFTER THE LAUNCH. Photograph by E. Muller.

FIXATION OF ATMOSPHERIC NITROGEN IN AMERICA.*

By GEORGE M. HEATH.

IT is said that for the undisturbed maintenance of our civilization, nothing is more important than continuity. The supply of raw material for the work of to-morrow is one of the foremost problems of to-day; and among the most pressing problems which now confront mankind is that of opening new sources of supply of fixed nitrogen—indispensable alike in peace and in war—in the industries of fertilizers and of explosives.

For centuries man has been drawing on the meager niter beds of Chili, at first slowly, and then as civilization has grown, with reckless speed until, if the truth were known, it would seem that the store of nitrates is in more imminent peril of exhaustion than even the coal supply—and the result of its exhaustion would be only less serious than the loss of fuel. It has been calculated by eminent scientists that at the present increase of consumption, the nitrate beds of Chili should be exhausted not later than 1940. What the fertilizer industry means to our civilization may be judged from the fact that the production of fertilizers in the United States alone has increased during the last ten years from 2,000,000 tons to over 3,000,000—and this with our abundance of virgin soil. The crops harvested annually upon the cultivated area of the United States abstract over 1,000,000 tons of nitrogen from the soil. Considerable of the nitrogen is returned in stable manure, and amounts to over 600,000 tons; but the United States consumes for fertilizers only 285,000 tons of Chili nitrate, corresponding to 47,500 tons of nitrogen. Thus you see the amount imported is only about 12 per cent of the deficiency produced by the removal of the crops.

To supply the rapidly increasing demand for food will necessitate the increasing of the wheat yield from an average of 12.7 to 20 bushels per acre. Careful experiments show that this can be accomplished by the use of 150 pounds of sodium nitrate per acre. In the United States, where 40,000,000 acres are estimated to be in wheat, this increase would make the sale of fertilizers amount to $150,000,000 per year. At the beginning of 1906 there were in operation 132 nitrate plants, with an estimated capacity of 3,846,450 tons annually. During the year ending March 31, 1907, the production and exportation was limited to 2,175,000 tons. The combine not only controls the output and exportation, but sends experts in the use of nitrate to different parts of the world to study conditions and to extend the sales. It is estimated that the 1906 exportations of Chilian nitrates sold for $75,000,000. In ten years the Chilian nitrates have increased in exportation 60 per cent, in price 60 per cent, and in value 250 per cent. These statistics will, no doubt, make clear to you the importance of the "nitrogen fixing" problem. I shall show you presently that this problem has been solved; and as the atmosphere over each square mile of earth surface will furnish more nitrogen than is to be found in all Chili, we have no need to fear the near exhaustion of the world's supply of fixed nitrogen. I might say that the "fixing of nitrogen" has been solved in three different ways.

(*a*) The Direct Union of Nitrogen and Atmospheric Oxygen.—This is brought about through the agency of the electric arc, and results in the formation of nitric oxid, which is subsequently converted to nitric acid or a nitrate or nitrite.

(*b*) Combination of nitrogen with a substance other than oxygen, usually a metal or metallic carbid. The resulting compounds are nitrids or cyanids, or derivatives of either cyanogen or ammonia, and are not readily converted to nitrates.

(*c*) Fixation of Nitrogen by Bacteria or Growing Plants.—This process, it is obvious, is inseparably connected with agriculture, and is only indirectly of interest to manufacturers, since it does not attempt to produce nitrate in a marketable form for the chemical industry.

Work upon the problem of causing nitrogen to combine with the oxygen of the air dates from the discoveries of Priestley in 1785 and of Cavendish in 1787, who observed that nitric acid was produced when electric sparks were passed through moist air. From that time until 1897 little or nothing of importance

* Read before the Philadelphia Section of the American Chemical Society.

was done on the subject, but during the past ten years the question has been actively studied along both technical and scientific lines.

Chemically, the subject presents no difficulties, as the reactions involved are all simple and well known, and are expressed in the following equations:

(1) $N_2 + O_2 = 2NO - 43.2$ calories.

(2) $2NO + O_2 = 2NO_2 + 39.1$ calories.

(3) $3NO_2 + H_2O$ (warm) $= 2HNO_3 + NO$.

(2) and (3) proceed successfully.

Or (3a) $2NO_2 + H_2O$ (cold) $= HNO_3 + HNO_2$.

Restated, the above equations denote that the electric spark or arc causes one volume of nitrogen to combine with one volume of oxygen with formation of two volumes of nitric oxid. The reaction is endothermic, and 21.6 calories of heat are absorbed for each grain molecule (30 grammes) of nitric oxid produced. Hence the temperature of the gases quickly falls to a point where reaction ceases, unless the source of energy is continually supplied. Second, after the nitric oxid is formed, it combines with more oxygen to form nitrogen dioxid. This reaction is exothermic and proceeds spontaneously, 19.55 calories of heat being liberated for each grain molecule (46 grammes) of nitrogen dioxid formed. Third, the "red fumes" of nitrogen dioxid react with water in two ways, depending upon temperature and concentration. If the water is cold and does not already contain much acid, the products are nitric and nitrous acids, as in equation 3a. If the water is warmer, very little nitrous acid is formed, and the products are nitric acid and nitric oxid, as in equation (3). The nitric oxid thus formed again takes up oxygen, as in (2), and the reactions proceed as long as both nitric oxid and oxygen are present. The nitric acid formed mixes with the water used for the process, and by recirculating this weak acid through the absorption system it may be brought up to a strength of 50 per cent nitric acid, which is about the limit obtainable in practice.

The first difficulty in the process arises from the fact that the first reaction is reversible, and that after the nitric oxid is formed, a large amount will be decomposed unless it is quickly cooled, and much of the scientific investigation has dealt with methods and devices for producing the necessary hot-cold effect.

It is generally accepted among scientists that the oxidation of nitrogen in the electric arc is a purely thermal phenomenon, and that the electricity plays no other role than the furnishing of heat. Hence, theoretically, any source of heat which will give the desired temperature can be utilized, although practically the electric arc is the only known means of obtaining the necessary hot-cold effect.

In order, therefore, to obtain the maximum yield of nitric oxid for a given expenditure of electrical energy, the efforts of experimenters have been, first, to obtain the highest temperature practicable; second, to subject the largest possible amount of air to this temperature until equilibrium is obtained; and third, to cool the gases quickly from the high temperature of the arc to a temperature below 1,000 deg. C. in order to prevent the decomposition of the nitric ~~acid~~ oxide which has been formed.

It is quite generally known that Bradley and Lovejoy were the first to attempt the manufacture of nitric acid from the air on a commercial basis. A plant was built at Niagara Falls, but never attained a commercial success. In their process high potentials of 10,000 volts were employed. A rotating framework with projecting electrodes was used, dividing up an arc of great energy into a large number of small arcs. As many as 414,000 arcs per minute were obtained with an apparatus using only 5 kilowatts. This process if worked commercially would require a large number of units of plant, owing to the small amount of electrical energy condensed in each arc. However, on August 28, 1906, six United States patents were issued to Lovejoy, covering apparatus and methods for subjecting gases to high-tension discharges and indicating that the investigations at Niagara Falls are being continued, but the patents do not indicate that the work is along a line that is likely to give very successful results. On September 10, 1907, a patent was issued to C. P. Steinmetz, covering apparatus and method for subjecting gases to the action of an electric arc of minimum volume and greatest practical length. A rotating deflected arc is used, which serves the double purpose of extending the sphere of action of the arc, and of limiting the time within which the arc acts upon any portion of the air which passes through the converting chamber.

Kowalski and Moscicki met with the same obstacles as Bradley and Lovejoy, and during the past year abandoned their previous work, and adopted a method based on the use of two concentric ring electrodes; the arc passing from one ring to the other in radial direction. Here the flaming arc under magnetic deflection is used; and while it differs in construction from that used by Birkeland and Eyde, the principle involved is the same.

The Birkeland and Eyde furnace is designed to absorb 500 to 750 kilowatts of electrical energy. The arc produced plays between water-cooled copper electrodes, situated in a powerful magnetic field. The magnets are excited by means of a direct current, and consume an amount of electrical energy equivalent to 7 per cent of that used in the arc. The water-cooled electrodes absorb 7.5 per cent of the energy of the flame, and are removed for repairs after being in operation for about 300 hours. An arc of more than 1 meter in diameter and 35 to 40 millimeters thick is thus produced with a working potential of 5,000 volts and 50 cycles per second.

The low efficiency of a quiet, high-tension flaming arc in air results from the fact that it consists of several zones with gradually decreasing temperatures. Only the hottest inner zone is useful for the oxidation of the nitrogen. The nitric oxid, containing gases, must be removed from the sphere of influence of the arc as quickly as possible after the reaction has taken place, in order to prevent dissociation in the cooler parts of the flame of the nitric oxid produced in the hottest part. The cooler or outer zones can be dispersed by a magnetic deflection of the flame. The magnetic flux sets those parts of the flame into motion which carry the electric current, while, on account of the rapid moving, the less hot zones are completely suppressed.

I will now take up the peculiar high-tension spiral flame that constitutes the principal element in the Heath process for the fixation of atmospheric nitrogen. The furnace is extremely simple, and is constructed so as to allow the use of high pressures. Direct or alternating currents can be used. The electrodes are so arranged that the flame assumes a spiral shape in passing through the furnace, which itself is a conductor of the electric current. A flame several feet in length is obtained. By the use of air under a pressure of 29.7 pounds absolute, the temperature of the flame is greatly increased, owing to the added resistance of the air to the passage of the current. The temperature is estimated to be between 3,800 deg. and 4,200 deg. C. As the velocity of reaction is dependent upon the temperature, this higher temperature calls for a greater air velocity, and consequently allows a more rapid removal of the nitric oxid from the arc. However, too great a velocity of the air will extinguish the arc. With this furnace a yield of 1,200 to 1,400 kilos of nitric acid per kilowatt year can be obtained, and represents 75.7 per cent of that theoretically obtainable. The extra power necessary to compress the gases amounts to about 8 per cent of that used in the furnace, and the yield is increased fourfold per unit of energy consumed. Special cooling devices allow of a concentration averaging over 2 per cent, and a yield of 5 per cent has been obtained.

The equilibrium constant and the reaction velocity are said to increase when a mixture of equal parts of N_2 and O_2 are used, and the output is increased by about 20 per cent; but this would hardly cover the cost of producing such a mixture of nitrogen and oxygen. Here a question might arise whether the nitric-oxid concentration which is obtained in a vessel with a high-tension arc can be calculated from the nitrogen and oxygen concentration in the gas mixture under treatment according to the law of mass action. The law of mass action, I believe, is valid for the combustion of nitrogen at a constant temperature; but is it valid when the electric flame has a temperature drop? In the basis of experiments by Nuranen and Le Blanc, this question is answered in the affirmative; and is rendered theoretically plausible on the assumption of a mono-molecular reaction. If we have a direct oxidation of nitrogen by the electric discharge, that is, if there is a direct change of electrical energy into chemical energy, it would no longer be necessary to heat the air first to an extreme temperature and then cool it suddenly. When air is drawn through the furnace at less than an atmospheric pressure, it allows an increase in the free wave length of the ions and the kinetic energy which the ions can accumulate in moving through the electric field. Working under an atmospheric pressure of 100 millimeters, as high as 9 per cent concentration of nitric oxid has been obtained through the action of a "cold flame," as the temperature at no time was equal to 3,000 deg. C.

(To be continued.)

A SIMPLE FORM OF POLARISCOPE.*

By FREDERICK H. GETMAN, PH.D.

THE efficiency of a pile of glass plates as a means of polarizing light has long been recognized by instrument makers, and the best projection lanterns are to-day fitted with an elbow tube containing a bundle of plates for experiments with polarized light. The majority of high schools, however, are limited in their equipment of physical apparatus and few are provided with the necessary appliances for exhibiting even the simplest phenomena of polarized light.

It is with a view to putting within the reach of any physics teacher the means of illustrating to the individual members of his class some of the more important phenomena of polarization, that I describe the following simple piece of apparatus.

While the light reflected from a bundle of plates inclined at an angle of 57.5 deg. to the incident ray is polarized in the plane of incidence the light transmitted through a pile of plates inclined at the complement of this angle is found to be polarized perpendicularly to the plane of incidence.

The suggestion is made in Edser's "Light for Students," that a pile of microscopic cover glasses might be arranged in such a manner as to yield a simple device for studying some of the polarization phenomena.

A piece of glass tubing ½ inch or more in diameter and about 6 or 8 inches long is selected and the ends are well rounded in the flame. In one end of the tube is placed a diaphragm *D D* made either of wood or cork. About twenty microscopic cover glasses are selected and carefully cleaned and their combined thickness measured; then a piece of velvet cork is cut with a suitable cutter so that it will just fit tightly in the tube *T T*. The cork is then bored with a borer, the diameter of the hole being larger than that of the diaphragm *D D*, and then a slot is cut in the cork of thickness equal to that of the total thickness of the cover glasses, and inclined to the axis of the cylinder at as near 32.5 deg. as possible.

The cover glasses are then fitted into the slot, care being taken to avoid soiling them with the fingers, and the whole assembled as in Fig. 1. The glass tube *T T* is then covered with photographic black paper to prevent the entrance of light except through the diaphragm *D D*.

The mounting of the tube is shown in Fig. 2 where *B B* is a base carrying a support *S S* through which the polarization tube *T T* passed at right angles. Over the tube *T T* is slipped a ring cut from a cork, *C C*, and into this is fastened with sealing wax a knitting needle, *P*, which serves as an index or pointer of the circular dial, *D D*, which may be graduated into four quadrants.

The complete apparatus may now be used in connection with another similar piece in studying the phenomena of polarization, one-half performing the function of polarizer while the other acts as analyzer.

The alterations in brightness at intervals of 90 deg. can be followed very satisfactorily and by interposing sheets of mica or stained glass between the two tubes very beautiful effects can be observed.

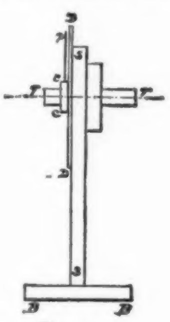


FIG. 2.

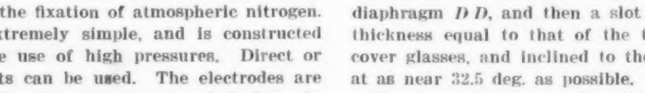


FIG. 1.

* School Science and Mathematics.

A reliable anti-freezing mixture for use in radiators is a 20 per cent solution of glycerine in water. This freezes at 17 deg. F. For very cold climates a 30 per cent solution which freezes at 10 deg. F. may be used, but for ordinary purposes the 20 per cent solution will prove very satisfactory. Crude glycerine should not be used, as it contains about 10 per cent of sodium salts, which may cause a deposit on the tubes of the radiator. What is known commercially as "pale distilled" glycerine may be used. This contains only 0.1 per cent of salt, a quantity so small as to preclude the incrustation of the tubes. The glycerine is not affected by a temperature of 210 deg. F., and needs replacement only at very long intervals. The glycerine and water should be mixed before being put into the radiator or the glycerine may be poured in after the water while the engine is running. Under no circumstances should the glycerine be poured in before the water as it has a much higher specific gravity than the water and will, consequently, when circulation begins, lodge in the water jackets, restrict the free circulation of the water and cause possible serious overheating.—The Commercial Motor.

ELEMENTS OF ELECTRICAL ENGINEERING.—XVIII.

CURRENT REORGANIZERS.

BY A. E. WATSON, E.E., PH.D., ASSISTANT PROFESSOR OF PHYSICS IN BROWN UNIVERSITY.

Continued from Supplement No. 1689, page 310.

It sometimes happens that the particular needs of some customer cannot be satisfied from the existing or common system of mains that convey the current. The supply may be of direct current, and the demand be for alternating; or the supply be alternating, and for some use the direct sort be imperative; even if already

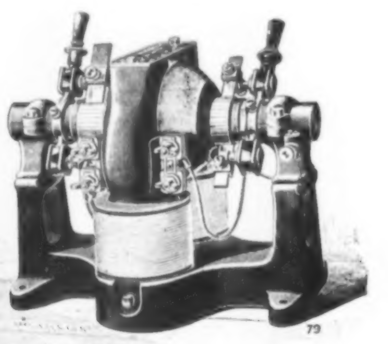


Fig. 83.—Dynamotor for Exchanging Direct-Current Voltages.

direct, it may be of improper voltage. Various other disagreements may readily be imagined. Of course the "system" of supply is adopted which will best satisfy the largest number of users, and then for the special needs of others accessory apparatus must be installed on the customers' premises that will make the desired alterations. Even in the case of a central station, especially if it be one receiving or delivering electrical energy over long distances, such auxiliary apparatus would commonly be found—its functions rather puzzling to a novice, yet contributing in a high degree to the practicability or economy of the operation of the entire plant.

The name "reorganizers" has been suggested for this class of apparatus—most of it involving some rotating parts—but the reader will better understand just what is meant after reading the article. The real definition can then perhaps be better imagined than expressed.

The most common cases encountered are those in which (1) the supply is of direct current, but the voltage is either too high or too low; (2) the supply is of direct current, but alternating currents of one, two, or three phases, and of appropriate voltage, are desired; (3) the converse of case (2) may more often be met; (4) alternating currents of one voltage and number of phases are to be exchanged for another voltage and number of phases, but of the same frequency; (5) the same case as (4) but with a change in frequency also imposed.

It is to be expected that some of these changes may be accomplished in more than one way, yet each of these has peculiar qualifications or limitations, and it will be appropriate to compare their utility. Definite names have been applied to most of these devices—more or less suggestive or familiar to the reader. These are, in the order of the above list, (1) dynamotors, motor-generators, boosters, converters, or inverted converters, "Scott" connected transformers, and frequency changers. The simple transformer for changing from one alternating voltage to another need not here be considered, for that topic formed the subject matter of Chapter XVII.

Instances under the first of these conditions are met when the regular supply is from the original low tension, or "Edison" system, of 110 or 220 volts, such as is found in the congested portions of almost all large cities, and a voltage of from 2 to 10 volts is desired for electroplating purposes, or of 25 volts for charging storage batteries in a telephone exchange, or 70 to 140 volts for operating telegraph circuits. The simplest sort of machine to make the necessary transformation is illustrated in Fig. 83. In this is seen a single field magnet and armature, two commutators with their respective brushes, but no pulley. One commutator is larger than the other, therefore suggestive of larger current carrying capacity. Though not discernible, the armature winding is really double, one consisting of relatively fine wire, and attached in the regular manner to the right-hand commutator, and the other of coarser wire, and attached to the other commutator. Naturally, some skill is required to put these two windings smoothly in place, yet well insulated from each other. The field winding is of sufficiently high resistance to be connected in shunt fashion to the same source of supply as the finer of the armature windings. In use, this fine wire part of the machine is merely a shunt motor, but as the armature rotates, it complies with all the conditions for generating an electromotive force in the coarse wire; the electromotive force in this latter will bear the same ratio to the supply as that of the number of turns in the two windings. It is therefore a matter of apportioning the number of turns to fit the needs of each individual case. In consequence of the larger current allowable from the coarse wire, its commutator must be of larger dimensions than the other. Such a machine has, inherently, only one economical voltage of supply, for this is at once involved in the initial winding. It is seen to resemble the ordinary alternating current transformer, in which a definite ratio of transformation is involved with every particular winding. Still further resembling the latter, the "dynamotor" is equally helpless to change that ratio by any change in the speed. In the alternating current case, the speed of the generator, and therefore the frequency of the alternations, might be changed; but the secondary electromotive force would still bear the same ratio to the primary. If, to give a higher motor speed, the field of the dynamotor be weakened, this increase could not raise the dynamo voltage; for, in consequence of the field magnet being common to both windings, the increase in speed of conductors would be just offset by the lesser magnetism. With no means of adjusting the voltage of the dynamo part

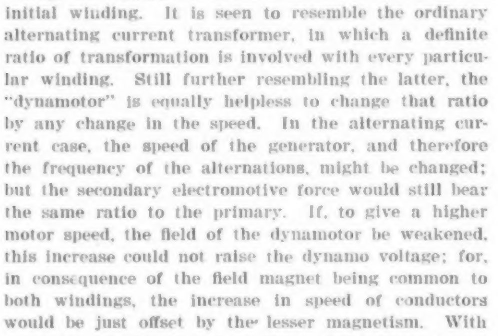


Fig. 84.—Motor-Generator, or Dynamotor With Independent Windings.

to the nicety often demanded by the user, these machines have largely been replaced by a variation of the scheme, in which the armatures are separate and each revolves under the influence of a field magnet of its own. A great variety of such constructions is made, and recognized under the name, "motor-generators."

A special use of the dynamotor is that in which both windings are alike, and their circuits connected in series across the mains of a double voltage generator. This is a device to enable a three-wire system to be operated from a single large generator. If such a generator supplies 220 volts, and it is desired to use 110-volt lamps, the double wound machine is connected across this circuit, and a third wire, to serve as the neutral, is led from the conductor joining the two commutators. The field winding is in shunt across the 220-volt mains. In case of a balanced load, the dynamotor runs idly, for its two 110-volt armature

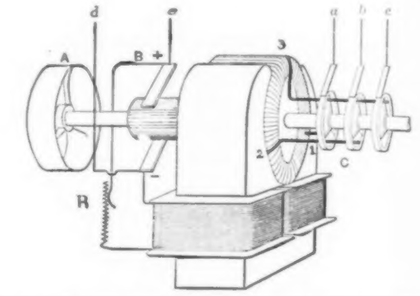


Fig. 86.—Elementary Three-Phase Rotary Converter or Double Current Generator.

windings in series set up a suitable counter electromotive force, and very little energy is wasted. If more load comes on one side of the system than on the other, the lighter side immediately draws about half the excess through one of the armature windings, making a motor of this part, and generates the other half needed in the other, or dynamo, portion of the machine. Since this double-wound machine needs to care for the unbalanced portion only of the load, it can be relatively small, and placed somewhat independent of the location of the main generator. In consequence of the particular functions fulfilled, this sort of dynamotor is often called a "balancer" or "equalizer."

A machine with independent windings closely imitating the one just described, but offering all desired control, is given in Fig. 84. Wide range of voltage is possible, for with a rheostat in the shunt field winding of the generator, the variation from normal to a minimum is made, while with a rheostat in the motor field, the speed may be increased, and values higher than normal secured. The act of putting two distinct armatures on the same shaft gives the same electrical conditions as if the generator were an entirely independent machine driven by means of a belt from some separate motor. The combination shown makes a very compact and noiseless arrangement. In case, too, of injury to one of the windings, repairs are more readily effected than when the two are on the same structure.

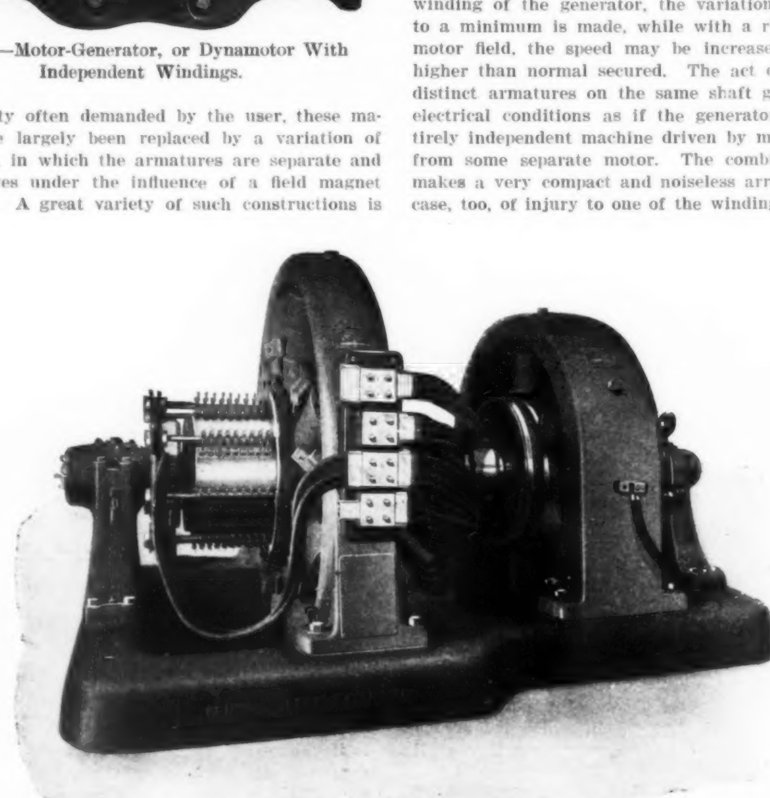


Fig. 85.—Booster Set of Large Size for Storage Battery.

A highly specialized form of the motor-generator is known as a "booster-set." In this, the generator may be wound for low voltages, but still higher than for plating purposes, and for large currents. The arma-

ture would be inserted directly in series with a railway feeder, in order to hold up the voltage at the distant end, or in a storage battery circuit, to assist the main generators during the charge, and, during the "peak" of the load, to help the batteries to discharge. The field windings of such generators are often various, and, dependent upon the conditions imposed, may be series, shunt, compound, differential, or even with triple windings. Some of the most beautiful refinements in dynamo design have been developed in the highly successful adaptation of booster control

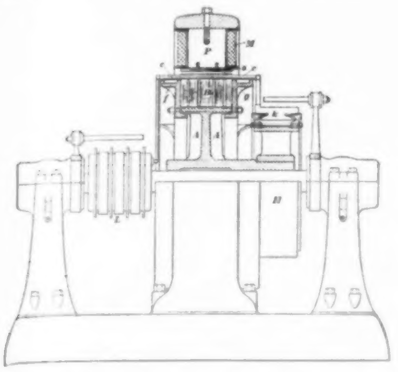


Fig. 87.—Section Through Rotary Converter, as Designed for Railway Service.

for storage battery operation. Especially in heavy railway service, where the demands for current may be sudden and severe, and quite out of direct reach of the generators alone, the booster will automatically transfer the fluctuations to the battery, and allow the generators to operate under fairly constant loads and with maximum economy. An idea of the size and appearance of such a set is given in Fig. 85. Of the two machines the one on the left is the generator; it has eight poles, and the armature output is 160 kilowatts at from 55 to 110 volts, meaning a current 1,450 amperes. The number of cables leading from the brush holders and the series coil is suggestive of large current capacity. The motor has six poles, is of 230 horse-power, and is supplied at the standard railway potential of 550 volts. The speed is 450 revolutions per minute. Of course, such a piece of apparatus wastes some energy—far more must be put into the motor than is secured in return out of the generator, but a working efficiency of 75 per cent to 80 per cent is readily secured. This represents, however, only a fraction of the entire output of a station, and the losses are fully offset by various economies in other directions. In such a set, the relative number of amperes in the two circuits is graphically shown by the small twin cables on the motor, and the large quadruple ones on the generator.

By making the motor portion of such a set adapted for running on alternating currents, it is seen that still further opportunities are open to its use. In case alternating current was at high voltage, the set would regularly have three or four bearings for the shaft, and the latter in two portions connected through an insulating coupling. Whether with or without this insulating feature, the applications of such motor-generator sets are very large, ranging from those adapted for small experimental purposes to the running of really large generators in central stations.

direct current, on the three-wire system, was to be supplied, the two direct current generators of the set would be joined in series to supply that network of conductors, and the power to drive them delivered to the motor. The motor itself might be of the induction type, and self-starting; but a higher efficiency, and closer regulation of speed and voltage are secured through the use of those of the synchronous type.

In alternating current generating stations it is common to have the engines or water wheels of appropriate sizes to drive the main machines only. Direct current is, of course, imperative for energizing the field magnets of the generators, and this is conveniently obtained from a suitably small machine driven from an alternating current motor. The combination is commonly denoted as a motor driven "exciter." For making a start from a condition of complete shutdown, such a set would be helpless; consequently to tide a station over such a period, reliance would need temporarily to be placed in a small independently driven dynamo or in a storage battery.

One arrangement of the motor-generator set has found considerable adoption in connection with street lighting. When the transmission is by three-phase alternating currents, yet direct currents are preferred for the arc lamps, synchronous motors are usually coupled, at their two ends, to two large arc dynamos, often of the most modern Brush 4-pole type, and thus make double sets for changing from constant potential, three-phase alternating to those of direct constant current sort. From each of these arc machines 100 to 125 lamps in series would be operated. At Buffalo, Niagara power, brought for a distance of twenty-six miles, is used to drive the motors; but the flexibility and convenience of this motor method is often utilized for transmissions quite within some one station. A notable illustration of this procedure is at the South Boston station of the Edison Illuminating Company.

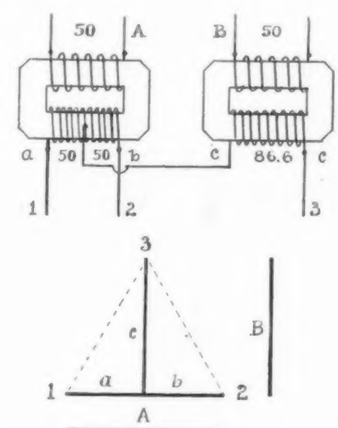


Fig. 89.—Two-Phase to Three-Phase Transformation or *Vice Versa.*

In this eighteen such sets are arranged in the same room as the main generators; each of the synchronous motors is of 200 horse-power, and drives two 106-light 6.5-ampere dynamos. Although the transmission is for a distance not over 100 feet, all belting, with its accompanying losses and waste of space, is saved, and an additional valuable gain is that any one set is not associated with some one particular engine.

"rotary converter." Abridged names are "rotary" and "converter." Schuckert & Co. exhibited the first one at the electrical exhibition in Frankfort, in Germany, in 1891. An ordinary multi-polar direct current shunt wound generator has been fitted with collector rings,

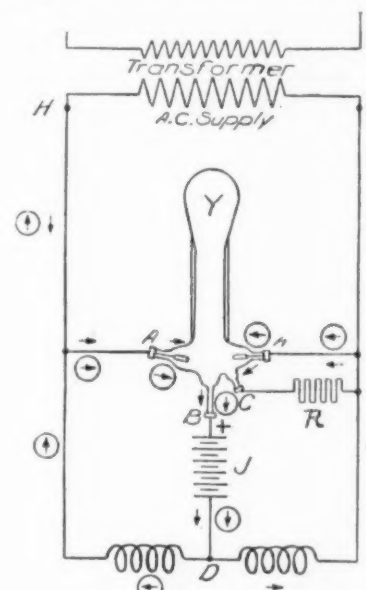


Fig. 90.—Connections and Circuits of Mercury Arc Rectifier.

and these were attached at suitable symmetrically located points of the same winding as that to which the commutator was still connected. Treated as an alternating current generator, all the conditions for three phases were provided, as diagrammatically represented in Fig. 58, of Chapter XIV. Ignoring these connections, it was, of course, possible to use the machine for direct currents, either as motor or generator. With field excited with direct current, the armature could deliver three-phase alternating currents; or half the output could be direct and the other half alternating. Further, if alternating currents were supplied in proper manner to the armature, the machine became a synchronous motor. The most interesting feature was then found that direct currents were obtainable from the commutator, just as if the armature was driven by an engine. That is, alternating currents could be delivered to the rings and direct current taken from the commutator. Of course, the same current that was put in at one place came out at the other; but the commutator directed or "rectified" the separate impulses into as truly a direct current as attainable from any machine. The converse was also found true—that the machine could receive direct currents at its commutator, and deliver alternating from the rings.

Great interest immediately attached to this discovery, and not many years elapsed before such machines were found installed in substations at distant points on railway lines. The current was transmitted from the central power house by means of high voltages, then transformed to suitably low potentials, and delivered to the rings of the converters, whence direct currents were led to the trolley wires.

A graphical representation of the arrangement of parts, and the location of the wires for a three-phase converter, is given in Fig. 86. The rings are at one end of the machine, with taps to three equidistant points of armature winding, while the commutator is conveniently at the other end. A pulley is here shown, but its place would ordinarily be taken by an induction motor, used for starting just as that shown in Fig. 68, of Chapter XV; or, in case the machine was in a central station, and used for changing direct current into alternating, a separate exciter could be substituted, and give better control over the field than when the energy comes from the main armature. For it has been found that under such running of an "inverted" converter, an extra heavy load—and surely a short circuit on the transmission line—will admit such a lagging current in the armature as to weaken the field magnets, and dangerously accelerate the speed. If the field magnet of the separate exciter is normally worked at a very low degree of magnetization, even a slight increase in speed will so raise the electromotive force as at once to correct the tendency toward the weakening of the main magnets, and therefore the speed will be held closely at its proper value.

It may be of interest to learn just what relation exists between the direct and alternating electromotive forces; that is, to find what number of volts acting at one end of the machine will produce a given number at the other. Reference to the diagrams shown in Chapter XIV will be helpful. If every one of the

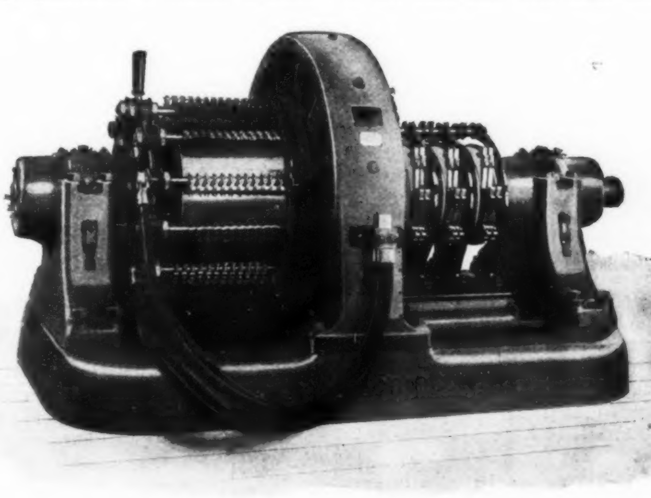


Fig. 88.—Three-Phase Rotary Converter for Large Currents, for Electrolytic Refining.

Very often the motor shaft is extended in both directions and independent direct current machines driven. For such, the alternating currents, in two or three phases, would be transmitted from some remote source of supply, but at such voltage as to be dangerous and otherwise unfitted for distribution to customers. If

From whatever source the alternating current may come, any one of the motors is equally in condition to run.

The first sort of machine to change alternating currents to direct, and *vice versa*, and one still popular for railway and some other service, is now called the

loops in the ring winding in Fig. 59 be imagined as attached to a commutator segment, the direct current conditions will be filled. The four taps to the collector rings will provide for two-phase alternating currents. Imagining now the direct voltage, as measured across the brushes, to be called 1, then the alternating, measured across either of the opposite points, will be, as explained in the text, 0.707; draw then a diameter through A_1 and A_2 to represent this effective value. That is, if the machine be used as a double current generator, a certain direct voltage would be impressed on one circuit, while alternating ones, 0.707 as great, would be acting on each of the two-phase circuits. Consequently, except for such losses as may be due to the resistance and reactance of the armature, if 550 volts direct is desired, 550×0.707, or 389 volts, alternating, must be impressed. This would ordinarily be afforded through the medium of special transformers. To ascertain what the value for the case of three phases would be, draw, in Fig. 58, a diameter through the point A; this will, as before, represent points between which the alternating voltage is 0.707 of the direct. Draw a line connecting A with either B or C; by measurement or calculation this length, representing the voltage in the three-phase circuits, will be found to be 0.612 of the direct. Then for a direct voltage of 550, 337 volts alternating must be impressed on each of the three ring circuits.

The particular ratios, just deduced, are seen to be dependent upon the armature connections, and no reference has been made to any particular strength of field. This is an important point, and indicates at once that control of the terminal voltage cannot be sought in the ordinary direct current manner. Slight adjustments of field strength are possible, and compound windings have met with favor in railway work; but the most satisfactory and complete means are found in introducing variable reactance coils into the alternating current circuits, between transformers and rings. This, of course, results in varying the number of impressed volts, and the direct current voltage will follow in the computed ratio.

Two-phase converters have four rings, therefore they are capable of passing more current than the three-phase, with its three rings. Sometimes a double three-phase winding is used, and somewhat improperly called six-phase; still more current can be passed by such a winding than even the one with four rings. With a certain direct current rating, the same winding will get no hotter, when used as a three-phase converter, though carrying 1.32 times as much current, or with two phases, 1.62, and with six phases, 1.92. For the amount of current they convey, the rotary converters, therefore, need not be so large as the generators from which the energy originally comes. Most converters operate on 25-cycle circuits, and the number of poles and speed to give this frequency are quite within easy engineering practice. For 60 cycles, however, requiring more poles and higher speeds, the conditions are not at all favorable; in addition to the expected mechanical drawbacks, there is increased difficulty in producing sparkless communication.

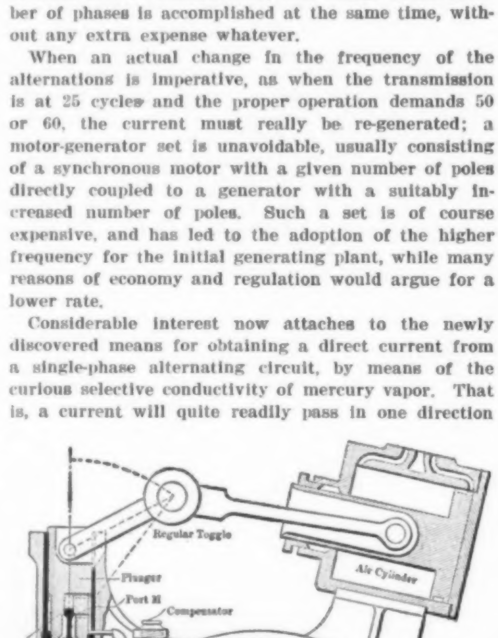
Sometimes irregularities in the supply circuits, or periodic fluctuations in the load, especially when a number of converters are operated in parallel, set up surgings in the speed of armature, even to the extent of causing the machines to break step with the necessary condition of synchronism, and suddenly stop. To prevent this accident, heavy copper grids are placed around the pole tips, or are imbedded in their faces; by this provision, any fluctuations will induce such large local currents as at once to serve as effective dampers.

In Fig. 87 is given a partial half-section through a standard three-phase converter for railway service, and in Fig. 88 the outside appearance of a special one for passing very large currents for electrolytic refining.

Since two-phase apparatus has a slightly higher current capacity than the same weight of materials arranged for three phases, and the former has some good qualifications for local distribution not found in the other, the two-phase sort is often installed; yet for purposes of long-distance transmission, the advantage lies with three phases, for only three-fourths as much copper is required for the line wires, and one row of insulators is saved. Means for exchanging the number of phases has therefore been sought. Of course a motor-generator set would accomplish the result, but in too expensive a manner. The problem was ingeniously solved by Mr. Scott, chief electrical engineer of the Westinghouse Company, by the use of special transformers. These must be made in pairs, with the two-phase windings alike; but one of the windings for the three phases has a tap brought out in the center, while the other winding has only 0.866 as many turns as the first. A representation of the circuits and their geometrical combination is given in Fig. 90. A and B are the two-phase portions, and have the same number of turns; it is to be remembered that one of these windings receives its impulse one-quarter period later than the other. In one transformer the coils a and b, with the tap in the center, give the terminals 1 and 2, while the coil c in the other transformer, joined to this middle point, gives terminal 3. Since the device can be used either way, to change two to three, or three to two phases, either set of coils may be primary or secondary. In the geometrical diagram, the phase A is to be regarded as acting on its other winding a and b, while the phase B acts on winding c, erected as a perpendicular at the middle of a-b; the instantaneous sum of a or b and c is just equal to a plus b; therefore the electromotive forces between points 1, 2, and 3 are equal and follow a genuine three-phase order. The numbers given in the diagram are not to be taken as actual, but proportional to the real ones, for an illustrative case of exchange between 50 volts, two-phase, and 100 volts, three-phase. Since the power transmission usually involves the use of some sort of transformers, this change in the number of phases is accomplished at the same time, without any extra expense whatever.

When an actual change in the frequency of the alternations is imperative, as when the transmission is at 25 cycles and the proper operation demands 50 or 60, the current must really be re-generated; a motor-generator set is unavoidable, usually consisting of a synchronous motor with a given number of poles directly coupled to a generator with a suitably increased number of poles. Such a set is of course expensive, and has led to the adoption of the higher frequency for the initial generating plant, while many reasons of economy and regulation would argue for a lower rate.

Considerable interest now attaches to the newly discovered means for obtaining a direct current from a single-phase alternating circuit, by means of the curious selective conductivity of mercury vapor. That is, a current will quite readily pass in one direction



PNEUMATIC TOGGLE-JOINT RIVETER, WITH AUTOMATIC ADJUSTMENT FOR THICKNESS OF WORK.

and scarcely at all in the other. This condition can be obtained only in case the electrodes are of different materials. Reference to Fig. 89 will give an idea of the circuits. A glass bulb Y, ten inches or more in length, from which the air has been exhausted, contains a few ounces of liquid mercury in contact with a bottom electrode B, called the cathode. A and A^1 are other electrodes, terminating in graphite, and called anodes. These latter are connected to the source of alternating currents. From the bottom electrode connection is made, if batteries are to be charged, to the positive pole. Adjustable reactive coils, for purposes of regulation, are inserted at F and E. With no vapor in the tube no current can pass in any direction. By means of an auxiliary anode C current can flow through an ohmic resistance R and some liquid mercury in a narrow channel, thereby filling the bulb with vapor and breaking this starting circuit. At one instant current will follow a path from H in the direction shown by the simple arrows, through A, B, the batteries J, D, E, and to the transformer terminal G. At the next instant the path will be that shown by the arrows within circles, but still in the same direction through the batteries. Current will not pass from A to A^1, or A^1 to A, for both these terminals are of the same material.

The current through J is unidirectional, and entirely suitable for battery charging purposes, or for operating arc lamps that demand direct currents; but the flow is pulsating, therefore not best fitted for running motors. As expected, the vapor has some resistance even in the direction that the current flows, and a constant drop of about 14 volts is suffered. A standard size of apparatus operates on a 110-volt 60-cycle alternating circuit, and can supply 16 to 45 volts and up to 25 amperes direct current. Efficiency is about 75 per cent. The life of the bulbs ranges between 600 and 1,000 hours of use. In warm places it may often be necessary to run a fan motor to provide for the effective condensation of the vapor on the walls of the glass.

For general experimental purposes, it is likely that a motor-generator set would allow greater flexibility of control, and not represent a much higher first cost than mercury "arc" with its considerable accessories. For steady loads, as for battery charging, or for series arc lamps, an extensive adoption is predicted.

Chapter XIX will explain the construction and connections of instruments for measuring direct currents.

SOME LATE IMPROVEMENTS IN COMPRESSIVE RIVETERS.*

By CHESTER B. ALBREE.

THE comparative advantages of the various forms of compressive riveters—hydraulic, hydro-pneumatic, direct pneumatic, and pneumatic toggle-joint—have been considerably discussed and are fairly well understood. Each of them has certain advantages not possessed by the other. In this paper is described a new riveter in which some of the advantages of the various forms are combined, together with some additional improvements not hitherto attained. This riveter has the action of the toggle-joint type, with its increasing pressure toward the end of the stroke, where pressure is most needed in heading the rivet. It also has the valuable feature of the plain hydraulic machine in not requiring adjustment of the riveting jaws for work of different thicknesses. The machine is self-adjusting in this respect, and always gives the same terminal pressure, even though the thickness riveted may vary from one stroke to another.

In the cut is shown the perfected form. The piston in the air cylinder is connected to the plunger by a toggle mechanism of the usual construction. The pressure from the toggle is transmitted to the top of the ram and also through a pipe to the adjusting cylinder. The ram being small in area and free to move, advances rapidly and continues until the rivet die on its extension strikes the projecting rivet. As the plunger continues, the pressure in the cylinder is limited by the pressure due to the spring in the adjusting cylinder, there being free communication to it through port M and the pipe shown. This pressure is only 20 pounds per square inch, insufficient to upset the rivet beneath the ram. Hence the liquid will now displace the piston in the adjusting cylinder, the ram remaining stationary.

Referring to the cut, it will be noted that the extension of the plunger, when fully up, still projects into the smaller area of the ram cylinder; and that cup leathers are used to pack it. In the interior of this extension is a valve of the poppet type, but having a stem carrying on its end a small piston. This valve is normally held open by a spring. So long as the pressure above and below this small piston is the same, the spring holds the valve open, but when the pressure below is greater than above the piston will move up, closing the poppet valve. This occurs only when the port M leading into the space below the small piston is closed, due to its passing from the large diameter bore to the smaller ram bore. When closed, the toggle pressure acts on the liquid below the plunger extension, raising the pressure sufficiently to move the small piston and connected valve, and later exerting very high pressure on the poppet valve, shutting it perfectly tight.

During the downward motion of the ram the liquid beneath it is forced into the opposite end of the adjusting cylinder, against the spring pressure. It is obvious that the ram may move its whole adjusting stroke, or not at all, up to the time when port M is closed by entering the smaller diameter of the cylinder; after which the further travel of the ram is that of the plunger, until the ram meets opposition greater than the pressure of the toggle, when it will stop. This arrangement, therefore, automatically adjusts the point of maximum pressure to suit the work. On the return stroke we have the direct pressure beneath the ram, as well as the suction of the plunger, to raise the ram to its original position.

Leakage of the liquid is made up from a small storage, or compensating, cylinder, full of liquid, having a piston with a spring behind it, connected to the larger bore of the plunger by a pipe, having a check valve in it. Whenever there is pressure in the plunger cylinder, the check valve remains closed; but when the toggle is fully back, and the piston in the adjusting cylinder is against its cylinder head, so that no pressure due to its spring is exerted on the liquid, any loss of liquid will tend to create a vacuum in the plunger cylinder, and then the check valve will open, and oil flow out of the compensating cylinder, under the pressure of the spring acting in its piston, to replace that which is lost.

* Abstracted from a paper read before the Engineers' Society of Western Pennsylvania.

HEAT AND BUILDING MATERIALS.

DISCUSSION OF THE AUSTRIAN COEFFICIENTS.

BY W. W. MACON.

FEELING that the figures for the transmission of heat through building materials, as adopted by the Society of Austrian Engineers and Architects, might well be placed in the records of the American Society of Heating and Ventilating Engineers, especially as these figures allow for some interesting observations to be made in comparison with the present practice in this country, a translation was made of the published figures of that society, reducing the figures as given in the metric system to those of the English system here in use. Generally speaking, the coefficients are much higher than those regarded as high enough in this country, although it is understood that they are based on tests made in connection with the heating and ventilation of the new stock exchange at Budapest. The percentage increase or correction to be made for exposure or for the location of the rooms in a building is not so great as commonly employed in this country, but the difference is not material.

For example, after the amount of transmitted heat is calculated for a given room an increase of 20 per cent for a northern exposure is provided for, where it has been common to use as much as 35 in this country, and for east and west exposures the figures are increased by 15 per cent, whereas, a room with a western exposure is here subject to a factor increase of 35 per cent, and when on the east side of the building to one of 25 per cent, while a south room would have the calculation increased to say 15 per cent, where the Austrian figures do not allow for any increase for the southern exposure at all.

NOTE.—The figures in the following tables are the numbers of British thermal units per square foot of surface per hour for 100 degrees F. difference in temperature on opposite sides, other temperature differences being proportional, so that for 70 degrees difference the coefficients are 70 per cent of those in the tables.

OUTSIDE WALLS.

Thickness.	Brick. Plastered In and Out.	Brick. Plastered Inside.	Brick. With 2-Inch Air Space.	Brick. With 1-Inch Air Space.	Sandstone.	Limestone.	Concrete. Ordinary.	Concrete. With Air Space.
8 inches	72.0	78.0	..	41.0	.....		89.00	54.5
12 inches	56.0	61.0	48.5	35.0	104.0	115.5	77.00	50.0
16 inches	46.0	50.0	39.5	31.0	91.5	101.5	67.00	46.0
24 inches	34.5	37.0	30.0	.....	73.0	80.5	54.00	39.5
32 inches	27.0	29.0	24.0	......	60.0	67.0	45.50	34.5
40 inches	22.5	23.5	20.0	......	52.0	57.0	39.00	30.5

FLOORS AND ROOFING.

Plaster ceiling, planks, filling, double wood floor, 10.

Single wood floor, 59.

Plaster ceiling, air space, filling and soft wood floor, with cold air above, 18; do. with cold air under, 8.8.

Plaster ceiling, air space, filling and double floor, with cold air above, 15.8; do., with cold air under, 8.1.

Reinforced concrete ceiling with double flooring, 43.

Reinforced concrete ceiling with double flooring and plaster ceiling inclosing an air space, 33.6.

Reinforced concrete ceiling, with plaster expanded metal construction, concrete with expanding metal, filling and double flooring:

6-inch beam.....28	12-inch beam.....17
8-inch beam.....22	15-inch beam.....14
10-inch beam.....19	20-inch beam.....13

Reinforced concrete roof, with plaster, inclosing an air space, cement with expanded metal reinforcing, asphalt and gravel covering, 36.

Reinforced concrete roof without air space, 103.

Tar paper on 1-inch boards, 78.5.

Zinc and copper roofing on 1-inch boards, 80.

Slate roofing on 1-inch boards, 77.

Tiling, without boards, 178.

Corrugated iron, without boards, 383.

WINDOWS AND SKYLIGHTS.

Single windows (1/8 inch), 195, (1/4 inch), 192.

Double windows, 84.5.

Wired glass, 188.

Single skylight, 206.

Double skylight, 86.5.

DOORS.

Thickness. Inches.	Soft Wood. Inner.	Soft Wood. Outer.	Hard Wood. Inner.	Hard Wood. Outer.
3/4	82	89	108	125
1	70	76	98	113
1½	56	60	85	95
2	47	50	75	83
2½	38	41	66	73

PARTITIONS AND INNER WALLS.

Thickness Inches.	Wood.	Wood Plastered Both Sides.	Ordinary.*	Plaster Construction.
3/8	100	..	..	..
½	94	..	..	..
3/4	79	48	..	..
1	74	44	..	..
1½	..	38	115	112
2	..	..	110	106
2½	..	..	101	100
3	..	..	94	94
3½	..	..	89	90
4	..	..	84	85

* Discussion before the American Society of Heating and Ventilating Engineers.

* Brick partition walls plastered about 10 per cent less than outside, plastered brick walls.

WATERPROOFING CEMENT STRUCTURES.†

By JAMES L. DAVIS.

GENEROUS use of Portland cement will secure impervious concrete. Several structures, such as reinforced dams, standpipes, and tanks, have been successfully built with the concrete mixed in the ordinary manner in proportions about 1:2:4 or 1:2:3, without special care other than to secure a wet consistency. Tests not here given show that ordinary sands in mortar in proportions 1:2½ or richer are impervious. Also, so-called sand or silica cements make a somewhat tighter mortar than Portland cements.

By scientifically grading the aggregate, Mr. William B. Fuller has successfully built tanks with thin walls, of proportions about 1:3:7. Whether it is cheaper to use the larger quantity of cement or to grade the aggregate depends upon the relative local prices of cement and of aggregate, and the size of the work. These are the proved methods that are free from doubt as to enduring efficiency and strength, and are of reasonable costs.

It should be remembered that troweling on a plaster coat of mortar or washing with thin grout are but modifications of use of rich proportions of Portland cement.

The use of finer sand than is usually accepted for ordinary concrete work may prove to be of special value. Its advantage, if successful, will consist simply in cheapening the process of grading ordinary materials to an ideal analysis. Its effect on reducing strength is well known, and its use will in some cases be limited by strength requirements.

Puzzolan and sand cement are superior to Portlands in securing impermeability, but they are somewhat inferior in strength. Colloidal clay as a substitute for five per cent and ten per cent of the sand, or the substitution of one per cent or two and a half per cent solutions of alum sulphate, or possibly other electrolytes for the mixing water, may prove cheap and effective processes. The writer holds aloof from stronger recommendations at this time because of the limited range of the experiments, and the undetermined effect on permanence of strength. Successful application of the clay process would require special appliances for drying, pulverizing, and mixing.

The degree of imperviousness which may be expected from methods above described is such as to meet ordinary conditions, as the demand for dry basements, roofs, and walls, and the storage of water or its conveyance under moderate heads without objectionable loss or resulting damage from its escape.

Two questions of great importance, the solution of which are being sought, are whether a greater degree of protection for reinforcing steel than can now be secured is necessary, and whether it is practicable to construct in reinforced concrete to resist hydrostatic heads of 100 to 300 feet, such as is demanded for great dams and pressure conduits.

One of the results of investigations at the laboratory of the Board of Water Supply of the City of New York, of which the writer has charge, has been to confirm the often observed phenomenon of increasing imperviousness with time, commonly called the result of the "silting up" of the concrete. The action has not been fully explained, but whether it is physical or chemical, or whether it has some analogy to the *schmutz-decke* of the fine sand-filter, he who would construct impervious concrete may count upon its coming to his aid at least under conditions of moderate head of water in continued contact.

One set of experiments with mixtures as lean as 1:4:14 intended to secure the maximum possible degree of permeability to serve as drainage blocks through which seepage of water might be carried away, became so nearly impervious in twenty-four hours under a head of twenty inches as to make their use for the purpose intended doubtful. This was with the flow perpendicular to the bed of the blocks. With the blocks so placed that the flow was parallel to the bed, the flow was greatly increased.

The difficulties in securing perfect workmanship in mixing and placing the concrete, and avoiding the formation of bedding planes through the mass, are greater than are those resulting from lack of knowledge of what should be done.

† From a paper read before the National Association of Cement Users.

THE YTTERBIUM GROUP.

SEPARATIONS of the yttrium group, he always observed that ytterbia gave the salts which were the most soluble. The method which seemed the most practical for obtaining this substance free from yttria, erbia, and thulia, is the crystallization of the nitrates. In this way he obtained some time ago about 50 grammes of crude ytterbia corresponding to the definition given by Marignac. Since that time the author carried out the following researches and is continuing his experiments. He sums up his results as follows: He undertook a systematic fractionation of ytterbia in order to assure himself of the constancy of its atomic weight and of its spectrum characteristics. To this end he submitted the nitrates to new fractional crystallizations in nitric acid having a density of 1.3. Thus we obtain, after a long and difficult series of fractional treatment bearing upon twenty-two successive fractionations, a series of products which were first examined with respect to their absorption. The first fractions, numbered from 9 to 16, showed to a slight degree the absorption bands which alone served at present to define the element thulium. He then eliminated these fractions. The other fractions, which may be considered as pure ytterbium, were transformed into sulphates and analyzed. Far from being constant, the atomic weights varied in increasing progression from 169.9 for fraction 17, up to 173.8 for the last fraction number 31. Such a large variation suffices to show the complexity of the substance ytterbium. He then sought for thorium in the last portions of the fractionation. By the very efficacious method of Wyrouboff and Verneuil (action of hydroxyl on solution of neutral nitrates) he was able to separate from his products which had the highest atomic weight, about a twenty-thousandth part of thoria, but this could not have an influence on the measurements. By the method of arc spectra he could not show the presence of impurities in his products which were thus purified, and it was not doubtful that his specimens of ytterbia were mixtures of several constituents. By photographing on the same plate, and one above the other, the arc spectra of the extreme products of the fractionation, he observed in the spectrum of the last fraction (number 31), numerous bands which were strong for the most part and which could not be observed in the first fractional product (number 17) or which at least were very slight. Inversely, fraction 17 showed some weak bands which were absent in fraction 31 and were probably due to thulium. Independently of these bands, the two spectra presented a great number of bands which were common and of the same intensity. These bands are those which characterize the main mass of the initial matter whose impurities (thulium and new element) are accumulated, one at the head and the other at the end of the fractionation. He then composed the spark spectra of his earths. The differences found by this method are much clearer than for the arc spectra. First, there are a number of rays, 2869.3, 2899.9, 2962.5, 3050.9, 3131.4, 3362.7, etc., in the spark spectrum which must be attributed to thulium, which he observed in the fractions having light atomic weights (the least soluble nitrates). Second, the series of rays, 2701.8, 2754.2, 2798.3, 2900.4, 3020.7, 3254.5, 3647.9, are characteristic of the new element. They are easily observed in the fractions having a high atomic weight, or the most soluble nitrates. They are found here exclusively, or else extremely reinforced. Within the limits of his measurements these 34 rays form the relatively complete spark spectrum of the new element. None of them can be attributed to scandium, thorium, erbium, thulium, yttrium, or any usual element or earth except the former ytterbium. To this new element the author proposes to give the name *lutecium* (Lu) derived from Lutetia, the Latin name for Paris. Third, the other rays, included between the same limits and enumerated in the spark spectrum of ytterbium

recently described by Sir. W. Crookes with one of the author's former preparations, characterize the principal mass of the former element ytterbium. The author proposes to give to this body the name *neo-ytterbium* (Ny) so as to avoid confusion with the former element of Marignac. Fourth, the first known spectrum of ytterbium was described by M. Lecoq de Boisbaudran in 1879, using the new earth found by Marignac. This is a band spectrum. Observing by Lecoq de Boisbaudran's method the chlorides of the extreme earths of the present fractionations, he found that with the earths of low atomic weight (neo-ytterbium) the band γ of Lecoq de Boisbaudran was absent. On the contrary, with earths of high atomic weights very rich in lutecium this band γ is higher in intensity than the other bands of the spectrum. The bands α (from $\lambda = 559$ to $\lambda = 552$) and β (from $\lambda = 576$ to $\lambda = 568.5$) seem thus to characterize the neo-ytterbium and the band γ (from $\lambda = 517.5$ to $\lambda = 513$), the element lutecium. To resume, from the ensemble of the above observations it appears that the ytterbium of Marignac is a mixture of two elements, the neo-ytterbium and the lutecium. The atomic weight of neo-ytterbium is not far from 170, and that of lutecium seems not much higher than 174. We should say that Demarçay in 1900 named an element characterized by the rays 4008.2 and 3906.5, as *element θ*. He considered it as distinct from thulium and as lying between erbium and ytterbium. The author could not observe these rays, which were obtained by means of a special coil, neither in the spark nor in the arc spectra. On the other hand, M. Auer von Welsbach (1907) announced recently that the fractionation of double oxalate of ammonium and ytterbium led him to observe some variations of spectra which he did not mention in detail. He gave no measurement of the rays which he observed between λ 7,000 and λ 5,000, and did not specify the elements which he supposed to exist in the former element ytterbium.

NATURAL MONUMENTS.

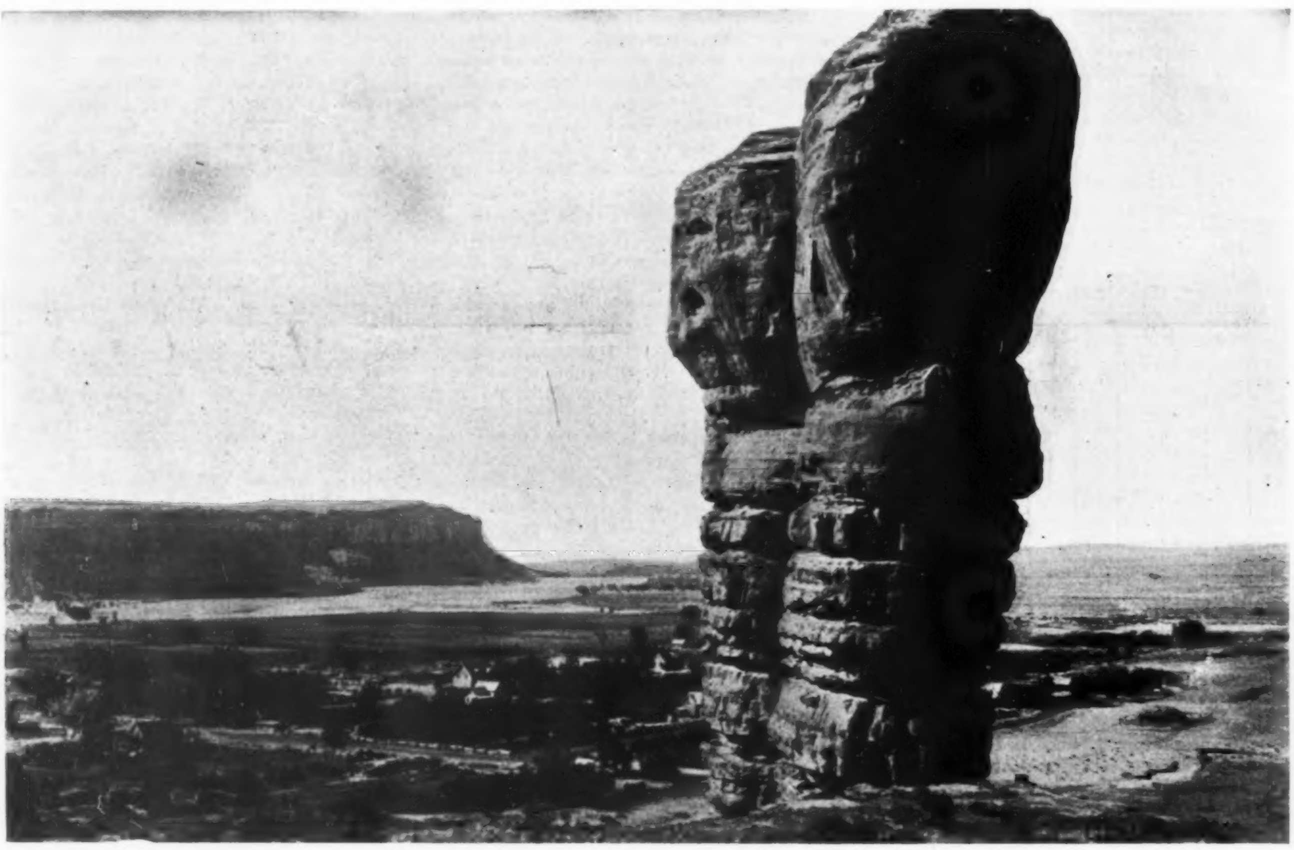
SOME CURIOUS FORMATIONS.

BY CHARLES GOODMAN.

MANY parts of this country, especially certain portions of the far West, have been generously endowed by Nature with striking and curious formations and natural monuments. The fantastic colorings and strange terrace-like conformations of certain of the so-called "bad lands" or of the canyons, such as the famous one of the Colorado, are well known to the general traveling or reading public. Others, however, of Nature's carvings, no less interesting and wonderful, possess only local renown, for various reasons, and are frequently unknown beyond their immediate vicinity. That it is remarkable that this state of affairs exists is attested by the description of the Sheepeater's Monument, described in the SCIENTIFIC AMERICAN about two years ago and by the accompanying engravings.

Astonishingly weird as the Sheepeater's Monument is, those described herewith appear to be far more stupendous. They are located on the lower San Juan River in southeast Utah. Beside some of the natural towers of this region, the 75 feet height of the Sheepeater's Monument appears almost insignificant, for its rivals here rise to elevations of 75 to 775 feet, and there is one, named El Capitan, away out on the Painted Desert, 40 miles south of the river, that is said to attain the sheer height of 800 feet above the level of the surrounding plain.

Two of the photographs are of the so-called Twin Towers, which measure 273 feet from the top of the right-hand tower to the base of the cliff, by actual measurement, as shown on the engraving. The towers proper rise 152 feet above the cliff on which they rest. They are roughly rectangular in cross section, and have an average thickness of about 28 feet. In the first of these two photographs, the "Twins" are seen in the immediate foreground rising like giants from the top of the cliff, and like sentinels keeping silent watch over the town and valley below. They were once an integral part of the mesa or table lands seen at the left and on the south side of the San Juan River, and which overspread like an unbroken sheet all this part of the country, say 30,000,000 years ago.



BLUFF CITY ON SAN JUAN RIVER, UTAH. TWIN MONUMENTS IN FOREGROUND, 152 FEET HIGH.
NATURAL MONUMENTS.

Nature has here given us one of her greatest examples of erosive carving, and has placed before students of geology a problem presenting many difficulties in explanation. However, the generally accepted belief now is, that the actual carving was done by the rain, and that the mesa, usually consisting of mud mixed with boulders or conglomerate, being heated by the sun after a rain, would crack. Succeeding rains enlarged these cracks to furrows, and the furrows to gullies, till the material was cut up into a series of columns or pillars. The tops of these pillars are gradually worn off by succeeding rains until a stone is exposed, which protects the material immediately beneath it, and thus the column is carved out, beginning with the top, so to speak, and becoming longer and longer as the unprotected mud or other material is washed away on all sides. If the protecting stone falls off, the column wears away rapidly, until perhaps another stone is reached, which for a while prevents further disintegration. The upper part of the column is always thinner than the lower part, because it has been longer exposed to the action of the rain, and the sectional contour always conforms to that of the capping stone.

In the placer mining view, shown in the third photograph, a great balanced rock is seen high on the bluff, 336 feet above the river and about 1,000 feet distant therefrom. This rock is circular in form and is 60 feet in diameter. It rests on a small column 5 feet in diameter and 4 feet high, which in turn rests on a pedestal a little larger than the balanced rock. According to the oldest white settler of the district, it has remained unchanged in this position for thirty years. This rock forms a great landmark for many miles around, and like the Sheepeater's Monument has in some way, not known to the writer, been given a strange and inappropriate title. It has long been known as the "Mexican Hat." As will be seen by the photograph, it resembles a Mexican's hat about as much as the Sheepeater's Mountain resembles a sheep-eater. A short time after this photograph was taken, one of the sudden, terrific floods occurring in this part of the country came down the San Juan River, and before the current wheel and pump could be gotten to a safe anchorage, they were capsized and smashed, and the whole works swept down into the Gulf of California.

Prof. Stéphane Leduc recently delivered a lecture on "Diffusion and Osmosis" before the meeting held at Rheims in 1907 of the French Association for the Advancement of Science. Certain remarkable experiments are described dealing with the formation and properties of the so-called "waves of diffusion"; the

phenomena dealt with, although evidently due to the transmission of material particles, are accompanied by effects entirely similar to those produced by wave motion, especially in so far as they show interference and diffraction. It is stated also that by means of diffusion under certain chosen conditions, using merely solutions of different concentration colored with a little Indian ink, the phenomena of karyokinesis can be reproduced in their proper order and form. Peculiar growths, presenting an appearance similar to that of true vegetable growths, can also be obtained by leaving "seeds," consisting, for example, of copper sulphate mixed with sugar, in an aqueous solution of potassium ferrocyanide saturated with common salt, and containing more or less gelatin and other salts. In different experiments growths analogous to roots, rhizomes, stems, leaves, and terminal organs of true plants were obtained, each with a characteristic internal structure depending on the nature of the salts in solution. By these experiments the interesting question is raised, how far the morphology of ordinary plants is determined by purely osmotic phenomena.

WYOMING COAL FIELDS.

THE coal field on the western edge of the Rocky Mountains in Wyoming, just east of the great Grand River field, was surveyed during the summer of 1906 by a party of government geologists and a report on the work has just been issued by the United States Geological Survey as a chapter in Bulletin No. 316, which forms Part II of "Contributions to Economic Geology, 1906."

The area studied lies at the point where the Rocky Mountain ranges depart from their north-south course, so characteristic in Colorado, and swing westward across Wyoming to the Yellowstone National Park. At this point of change of direction the mountains are broken into a number of dome- and lozenge-shaped uplifts of greater or less extent and of considerable variation in trend, and the coal area of east-central Carbon County is thus a topographic and geologic basin, with an average altitude between 6,500 and 7,000 feet, almost completely rimmed by uplifts ranging in elevation from 7,500 to more than 11,000 feet. The North Platte River crosses the area surveyed west of its center, its principal tributary within the district being the Medicine, which drains the northeastern quarter of the field.

The surveying party consisted of Messrs. A. C. Veatch, in charge; Max W. Ball, Max A. Pishel, and Spencer R. Logan. A large number of coal samples were collected and forwarded to the fuel-testing plant of the Survey at St. Louis and subjected to analysis. The result of these analyses are incorporated in the report.

Coal was discovered in this area by Fremont in 1843, on Platte River near the mouth of Sage Creek, at a point now known as Coal Bluffs. In 1856 Lieut. F. T. Bryan, of the topographic corps of the United States army, surveyed a road from Fort Riley to Bridger Pass. He was accompanied by Mr. H. Engelman, geologist, and they reported coal not only on Platte River but north of the present village of Elk Mountain, near Medicine Bow River. Bryan reports that on August 18, 1856, they camped for a few days on an island in Platte River "to rest the animals and burn coal for the forge." The coal beds opened at this time were mined in a desultory way by emigrants and by the Overland Stage Company, whose stage ran across the southern portion of this territory from the summer of 1862 until a short time after the completion of the Union Pacific Railroad.

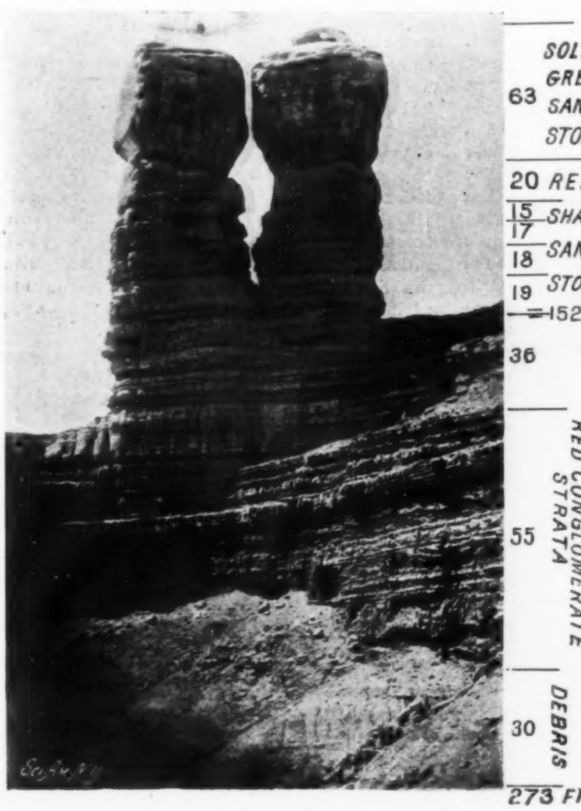
Regarding the commercial development of the coal in this region Mr. George R. Black, superintendent of the Union Pacific Coal Company, states:

"The first mines opened in Carbon County, Wyo., and worked to any extent, were opened by this company in 1868 at and near the town of Carbon, the last one being abandoned in 1902. There were seven of them. While the coal is not of the best, it is certain that the mines in that vicinity would still be working had not the main line of the Union Pacific Railroad passing through Carbon been vacated and taken farther to the north, where it passes through the Hanna coal. The mines at Dana, Carbon County, were opened in 1889 and abandoned in 1891 on account of the coal sparking too badly for locomotive use. The Hanna mines were opened in 1890 and are still in operation."

The coals in this field range from poor to high-grade bituminous. They are as a rule bright, brittle, and non-coking. The best coals in the area are found in the formation called by the geologists the Mesaverde, which contains also the high-grade coals of the field in Routt County, Colo.

The natural commercial market for coals from this section of Wyoming is limited on the east by Omaha, on the west by Rawlins, on the north by the Black Hills, and on the south by Denver. The western outlet is to-day blocked to a large degree by the higher-grade coals of Sweetwater and Uinta counties. At Denver the Carbon County coals come into competition with the Colorado coals, at Omaha with those of the Interior basin, and at the Black Hills with the Newcastle and Sheridan coals. The development of the metalliferous deposits in the ranges surrounding the basin may create a considerable local demand for this coal.

Black Stain for Hardwood.—For staining hardwood black the following preparation is recommended by the Holzmarkt: Dissolve 20 parts by weight of aniline hydrochlorate in 300 parts of water; add 1 part of cupric chloride and apply the fluid hot. When dry, paint the wood with a solution of 20 parts of potassium bichromate in 400 parts of water. This kind of stain is reported to be very durable and impervious to the action of acids.



THE TWIN TOWERS RISING FROM THE CLIFF.

The geological formation of the towers is given on the right of the picture.

PLACER MINING SCENE ON SAN JUAN RIVER NEAR BLUFF CITY, UTAH.

Balanced rock 336 feet above bed of river and 1,000 feet distant therefrom. The rock is 60 feet in diameter and rests on a pivot 5 feet in diameter.

NATURAL MONUMENTS.

A SIMPLE STATEMENT OF CHAMBERLIN'S HYPOTHESIS OF THE EARTH'S ORIGIN.*

By PROF. JAMES FURMAN KEMP.

BEFORE the eighteenth century closed and quite universally throughout the nineteenth, the earth was believed by geologists to have once been a highly heated nebulous or gaseous mass and to have passed through stages of refrigeration to its present state. This conception is the one formulated in accordance with the well-known "nebular hypothesis" and it marks, as has been stated, the connection of geology with astronomy and celestial mechanics. Grave doubts have arisen in the minds of some, however, as to its truth, and despite the significant astronomical evidence and analogies, the endeavor has recently been made by our fellow-countryman, Prof. T. C. Chamberlin, of Chicago, to formulate an alternative conception which would perhaps involve fewer difficulties. Instead of a highly heated, and subsequently cooled and solidified, gaseous original, minute particles of matter, which may have been molecules, are believed to have moved in orbits around a common center in a manner analogous to the solar system of to-day. In their evolution they became aggregated into larger bodies such as the planets and the earth; continuing in groups the motions and relations which they possessed when individuals. As the mass gradually increased, the pressure of the outer layers consolidated the core, and by the mechanical changes involved produced those internal stores of heat with which we are familiar in volcanoes and in deep borings and mines. Vapors or liquids in the original cold particles are believed to have been gradually squeezed out by this pressure. The little particles are called planetesimals or diminutive planets, and the hypothesis is styled the "Planetesimal Hypothesis."

It is perhaps too soon to forecast the influence of this new conception upon geologic thought. Like all attempts to formulate primeval conditions, its data are partly matters of observation, partly assumptions. Speculation enters in a very large degree, and, as in the case of various and widely differing estimates of the age of the earth based on assumed rates of cooling, once the data were provided, mathematical reasoning goes to a conclusion with unerring accuracy. But the correctness of the solution turns on the reliability of the original data, and where these are so largely assumptive the conclusions are from time to time subject to change. The field geologist, whose solutions of smaller problems turn upon carefully observed data, inevitably considers all the formulations of views regarding remote times and conditions essentially as working hypotheses, much less firmly established than many other results and to be taken much less seri-

* Abstracted from a lecture on Geology, delivered at Columbia University in the series on Science, Philosophy and Art.

ously. Yet we must have a starting point, and the striking contrasts of the older and the later views cannot but impress every one who reflects upon them. The former postulates a highly heated original; the latter a cold one. The one begins with gaseous matter; the other with solid. The one draws upon an original but diminishing store of heat; the other develops heat continuously by mechanical processes. In many ways the two are diametrically opposed; yet some have raised the question, whether, in order to obtain a swarm of separate cold particles, we must not in our thought go still farther back to a gaseous or nebulous source, and it is not clear that we have yet escaped the necessity of at least the essential feature of the nebular hypothesis.

MODERN BIOLOGY.*

A SIMPLE STATEMENT OF ITS ACHIEVEMENTS.

BY PROF. EDMUND BEECHER WILSON.

WE may admit that digestion is a purely chemical operation, and one that may be exactly imitated outside the living body in a glass flask. My question is, how does it come to pass that an animal has a stomach?—and, pursuing the inquiry, how does it happen that the human stomach is practically incapable of digesting cellulose, while the stomachs of some lower animals, such as the goat, readily digest this substance? The earlier naturalists, such as Linnaeus, Cuvier, or Agassiz, were ready with a reply which seemed so simple, adequate, and final that the plodding modern naturalist cannot repress a feeling of envy. In their view plants and animals are made as they were originally created, each according to its kind. The biologist of to-day views the matter differently; and I shall give his answer in the form in which I now and then make it to a student who may chance to ask why an insect has six legs and a spider eight, or why a yellowbird is yellow and a bluebird blue. The answer is: "For the same reason that the elephant has a trunk." I trust that a certain rugged pedagogical virtue in this reply may atone for its lack of elegance. The elephant has a trunk, as the insect has six legs, for the reason that such is the specific nature of the animal; and we may assert with a degree of probability that amounts to practical certainty that his specific nature is the outcome of a definite evolutionary process, the nature and causes of which it is our tremendous task to determine to such extent as we may be able. But this does not yet touch the most essential side of the problem. What is most significant is that the clumsy, short-necked elephant has been endowed—"by nature," as we say—with precisely such an organ, the trunk, as he needs to compensate for his lack of flexibility and agility in other respects. If we are asked why the elephant has a trunk, we must answer because the animal needs it. But does such a reply in itself explain the fact? Evidently not. The question which science must seek to answer is, How came the elephant to have a trunk? and we do not properly answer it by saying that it has developed in the course of evolution. It has been well said that even the most complete knowledge of the genealogy of plants and animals would give us no more than an ancestral portrait-gallery. We must determine the causes and conditions that have cooperated to produce this particular result if our answer is to constitute a true scientific explanation. And evidently he who adopts the machine-theory as a general interpretation of vital phenomena must make clear to us how the machine was built before we can admit the validity of his theory, even in a single case. Our apparently simple question as to why the animal has a stomach has thus revealed to us the full magnitude of the task with which the mechanist is confronted; and it has brought us to that part of our problem that is concerned with the nature and origin of organic adaptations. Without tarrying to attempt a definition of adaptation I will only emphasize the fact that many of the great naturalists, from Aristotle onward, have recognized the purposeful or design-like quality of vital phenomena as their most essential and fundamental characteristic. Herbert Spencer defined life as the continuous adjustment of internal relations to external relations. It is one of the best that has been given, though I am not sure that Prof. Brooks has not improved upon it when he says that life is "response to the order of nature." This seems a long way from the definition of Verworn—the "metabolism of proteids." To this Brooks opposes the epigram: "The essence of life is not protoplasm but purpose."

Without attempting adequately to illustrate the nature of organic adaptations, I will direct your attention to what seems to me one of their most striking features regarded from the mechanistic position. This is the fact that adaptations so often run counter to direct or obvious mechanical conditions. Nature is crammed with devices to protect and maintain the organism against the stress of the environment. Some of these are given in the obvious structure of the organism, such as the tendrils by means of which the climbing plant sustains itself against the action of gravity or the winds, the protective shell of the snail, the protective colors and shapes of animals, and the like. Any structural feature that is useful because of its construction is a structural adaptation; and when such adaptations are given the mechanist has for the most part a relatively easy task in his interpretation. He has a far more difficult knot to disentangle in the case of the so-called functional adaptations, where the organism modifies its activities (and often also its structure) in response to changed conditions. The nature of these phenomena may be illustrated by a few examples so chosen as to form a progressive series. If a spot on the skin be rubbed for some time the first result is a direct and obviously mechanical one; the skin is worn away. But if the rubbing be continued long enough, and is not too severe, an indirect effect is produced that is precisely the opposite of the initial direct one; the skin is replaced, becomes thicker than before, and a callus is produced that protects the spot from further injury. The healing of a wound involves a similar action. Again, remove one kidney or one lung and the remaining one will in time enlarge to assume, as far as it is able, the functions of both. If the leg of a salamander or a lobster be amputated, the wound not only heals but a new leg is regenerated in place of that which has been lost. If a flatworm be cut in two, the front piece grows out a new tail, the hind piece a new head, and two perfect worms result. Finally, it has been found in certain cases, including animals as highly organized as salamanders, that if the egg be separated into two parts at an early period of development each part develops into a perfect embryo animal of half the usual size, and twins are the result. In each of these cases the astonishing fact is that a mechanical injury sets up in the organism a complicated adaptive response in the form of operations which in the end counteract the initial mechanical effect. It is no doubt true that somewhat similar self-adjustments or responses may be said to take place in certain non-living mechanical systems, such as the spinning top or the gyroscope; but those that occur in the living body are of such general occurrence, of such complexity and variety, and of so design-like a quality, that they may fairly be regarded as among the most characteristic of the vital activities. It is precisely this characteristic of many vital phenomena that renders their accurate analysis so difficult and complex a task; and it is largely for this reason that the biological sciences, as a whole, still stand far behind the physical sciences, both in precision and in completeness of analysis.

What is the actual working attitude of naturalists toward the general problem that I have endeavored to outline? It would be a piece of presumption for me to speak for the body of working biologists, and I will therefore speak for only one of them. It is my own conviction that whatever be the difficulties that the mechanistic hypothesis has to face, it has established itself as the most useful working hypothesis that we can at present employ. I do not mean to assert that it is adequate, or even true. I believe only that we should make use of it as a working programme, because the history of biological research proves it to have been a more effective and fruitful means of advancing knowledge than the vitalistic hypothesis. We should therefore continue to employ it for this purpose until it is clearly shown to be untenable. Whether we must in the end adopt it will depend on whether it proves the simplest hypothesis in the large sense, the one most in harmony with our knowledge of nature in general. If such is the outcome, we shall be bound by a deeply lying instinct that is almost a law of our intellectual being to accept it, as we have accepted the Copernican system rather than the Ptolemaic. I believe I am right in saying that the attitude I have indicated as a more or less personal one is also that of the body of working biologists, though there are some exceptions.

In endeavoring to illustrate how this question actually affects research I will offer two illustrative cases, one of which may indicate the fruitfulness of the mechanistic conception in the analysis of complex and apparently mysterious phenomena, the other the nature of the difficulties that have in recent years led to attempts to re-establish the vitalistic view. The first example is given by the so-called law or principle of Mendel in heredity. The principle revealed by Mendel's wonderful discovery is not shown in all the phenomena of heredity and is probably of more or less limited application. It possesses, however, a profound significance because it gives almost a demonstration that a definite, and perhaps a relatively simple, mechanism must lie behind the phenomena of heredity in general. Hereditary characters that conform to this law undergo combinations, disassociations, and recombinations which in certain ways suggest those that take place in chemical reactions; and like the latter they conform to definite quantitative rules that are capable of arithmetical formulation. This analogy must not be pressed too far; for chemical reactions are individually definite and fixed, while those of the hereditary characters involve a fortuitous element of such a nature that the numerical result is not fixed or constant in the individual case, but follows the law of probability in the aggregate of individuals. Nevertheless, it is possible, and has already become the custom, to designate the hereditary organization by symbols or formulas that resemble those of the chemist in that they imply the quantitative results of heredity that follow the union of compounds of known composition. Quantitative prediction—not precisely accurate, but in accordance with the law of probability—has thus become possible to the biological experimenter on heredity. I will give one example of such a prediction made by Prof. Cuénot in experimenting on the heredity of color in mice (see the following table). The experiment extended through

Grandparents.... AG (white) AB (white)   AY (white) CB (black)

Parents .... AGAB (white)   AYCB (yellow)

Offspring..........			Observed.	Calculated.
	AGAY, ABAY, AGAB, ABAB	(White)....	81	76
	AGCY, ABCY	(Yellow)...	34	38
	ABCB	(Black)...	20	19
	AGCB	(Gray)....	16	19
			151	152

three generations. Of the four grandparents three were white albinos, identical in outward appearance, but of different hereditary capacity, while the fourth was a pure black mouse. The first pair of grandparents consisted of an albino of gray ancestry, AG, and one of black ancestry, AB. The second pair consisted of an albino of yellow ancestry, AY, and a black mouse, CB. The result of the first union, AG × AB is to produce again pure white mice of the composition AGAB. The second union, AY × CB is to produce mice that appear pure yellow, and have the formula AYCB. What, now, will be the result of uniting the two forms thus produced—i. e., AGAB × AYCB? Cuénot's prediction was that they should yield eight different kinds of mice, of which four should be white, two yellow, one black, and one gray. The actual aggregate result of such unions, repeatedly performed, compared with the theoretic expectation, is shown in the foregoing table. As will be seen, the correspondence, though close, is not absolutely exact, yet is near enough to prove the validity of the principle on which the prediction was based, and we may be certain that had a much larger number of these mice been reared the correspondence would have been still closer. I have purposely selected a somewhat complicated example, and space will not admit of a full explanation of the manner in which this particular result was reached. I will, however, attempt to give an indication of the general Mendelian principle by means of which predictions of this kind are made. This principle appears in its simplest form in the behavior of two contrasting characters of the same general type—for instance, two colors, such as gray and white in mice. If two animals which show respectively two such characters are bred together, only one of the characters (known as the "dominant") appears in the offspring, while the other (known as the "recessive") disappears from view. In the next generation, obtained by breeding these hybrids together,

* Abstracted from a lecture on "Biology" in the series on Science, Art and Philosophy, delivered at Columbia University.

both characters appear separately and in a definite ratio, there being in the long run three individuals that show the dominant character to one that shows the recessive. Thus, in the case of gray and white mice, the first cross is always gray, while the next generation includes three grays to one white. This is the fundamental Mendelian ratio for a single pair of characters; and from it may readily be deduced the more complicated combinations that appear when two or more pairs of characters are considered together. Such combinations appear in definite series, the nature of which may be worked out by a simple method of binomial expansion. By the use of this principle astonishingly accurate numerical predictions may be made, even of rather complex combinations; and furthermore, new combinations may be, and have been, artificially produced, the number, character, and hereditary capacity of which are known in advance. The fundamental ratio for a single pair of characters is explained by a very simple assumption. When a dominant and a recessive character are associated in a hybrid, the two must undergo in some sense a disjunction or separation in the formation of the germ-cells of the hybrid. This takes place in a quite definite way, exactly half the germ-cells in each sex receiving the potentiality of the dominant character, the other half the potentiality of the recessive. This is roughly expressed by saying that the germ-cells are no longer hybrid, like the body in which they arise, but bear one character or the other; and although in a technical sense this is probably not precisely accurate, it will sufficiently answer our purpose. If, now, it be assumed that fertilization takes place fortuitously—that is, that union is equally probable between germ-cells bearing the same character and those bearing opposite characters—the observed numerical ratio in the following generation follows according to the law of probability. Thus is explained both the fortuitous element that differentiates these cases from exact chemical combinations, and the definite numerical relations that appear in the aggregate of individuals.

Now, the point that I desire to emphasize is that one or two very simple mechanistic assumptions give a luminously clear explanation of the behavior of the hereditary characters according to Mendel's law, and at one stroke bring order out of the chaos in which facts of this kind at first sight seem to be. Not less significant is the fact that direct microscopical investigation is actually revealing in the germ-cells a physical mechanism that seems adequate to explain the disjunction of characters on which Mendel's law depends; and this mechanism probably gives us also at least a key to the long standing riddle of the determination and heredity of sex. These phenomena are therefore becoming intelligible from the mechanistic point of view. From any other they appear as an insoluble enigma. When such progress as this is being made, have we not a right to believe that we are employing a useful working hypothesis?

But let us now turn to a second example that will illustrate a class of phenomena which have thus far almost wholly eluded all attempts to explain them. The one that I select is at present one of the most enigmatical cases known, namely, the regeneration of the lens of the eye in the tadpoles of salamanders. If the lens be removed from the eye of a young tadpole, the animal proceeds to manufacture a new one to take its place, and the eye becomes as perfect as before. That such a process should take place at all is remarkable enough; but from a technical point of view this is not the extraordinary feature of the case. What fills the embryologist with astonishment is the fact that the new lens is not formed in the same way or from the same material as the old one. In the normal development of the tadpole from the egg, as in all other vertebrate animals, the lens is formed from the outer skin or ectoderm of the head. In the replacement of the lens after removal it arises from the cells of the iris, which form the edge of the optic cup, and this originates in the embryo not from the outer skin but as an outgrowth from the brain. As far as we can see, neither the animal itself nor any of its ancestors can have had experience of such a process. How, then, can such a power have been acquired, and how does it inhere in the structure of the organism? If the process of repair be due to some kind of intelligent action, as some naturalists have supposed, why should not the higher animals and man possess a similar useful capacity? To these questions biology can at present give no reply. In the face of such a case the mechanist must simply confess himself for the time being brought to a standstill; and there are some able naturalists who have in recent years argued that by the very nature of the case such phenomena are incapable of a rational explanation along the lines of a physico-chemical or mechanistic analysis. These writers have urged, accordingly, that we must postulate in the living organism some form of controlling or regulating agency which does not lie in its physico-chemical configuration and is not a form of physical energy—something that may be akin to a form of intelligence (conscious or unconscious), and to which the physical energies are in some fashion subject. To this supposed factor in the vital processes have been applied such terms as the "entelechy" (from Aristotle), or the "psychoid"; and some writers have even employed the word "soul" in this sense—though this technical and limited use of the word should not be confounded with the more usual and general one with which we are familiar. Views of this kind represent a return, in some measure, to earlier vitalistic conceptions, but differ from the latter in that they are an outcome of definite and exact experimental work. They are therefore often spoken of collectively as "neo-vitalism."

It is not my purpose to enter upon a detailed critique of this doctrine. To me it seems not to be science, but either a kind of metaphysics or an act of faith. I must own to complete inability to see how our scientific understanding of the matter is in any way advanced by applying such names as "entelechy" or "psychoid" to the unknown factors of the vital activities. They are words that have been written into certain spaces that are otherwise blank in our record of knowledge, and as far as I can see no more than this. It is my impression that we shall do better as investigators of natural phenomena frankly to admit that they stand for matters that we do not yet understand, and continue our efforts to make them known. And have we any other way of doing this than by observation, experiment, comparison, and the resolution of more complex phenomena into simpler components? I say again, with all possible emphasis, that the mechanistic hypothesis or machine-theory of living beings is not fully established, that it may not be adequate or even true; yet I can only believe that until every other possibility has really been exhausted scientific biologists should hold fast to the working programme that has created the sciences of biology. The vitalistic hypothesis may be held, and is held, as a matter of faith; but we cannot call it science without misuse of the word.

When we turn, finally, to the genetic or historical part of our task, we find ourselves confronted with precisely the same general problem as in case of the existing organism. Biological investigators have long since ceased to regard the fact of organic evolution as open to serious discussion. The transmutation of species is not an hypothesis or assumption, it is a fact accurately observed in our laboratories; and the theory of evolution is only questioned in the same very general way in which all the great generalizations of science are held open to modification as knowledge advances. But it is a very large question what has caused and determined evolution. Here, too, the fundamental problem is, how far the process may be mechanically explicable or comprehensible, how far it is susceptible of formulation in physico-chemical or mechanistic terms. The most essential part of this problem relates to the origin of organic adaptations, the production of the fit. With Kant, Cuvier and Linnaeus believed this problem scientifically insoluble. Lamarck attempted to find a solution in his theory of the inheritance of the effects of use, disuse, and other "acquired characters"; but his theory was insecurely based and also begged the question, since the power of adaptation through which use, disuse, and the like produce their effects is precisely that which must be explained. Darwin believed he had found a partial solution in his theory of natural selection, and he was hailed by Haeckel as the biological Newton who set at naught the *obiter dictum* of Kant. But Darwin himself did not consider natural selection as an adequate explanation, since he called to its aid the subsidiary hypotheses of sexual selection and the inheritance of acquired characters. If I correctly judge, the first of these hypotheses must be considered as of limited application if it is not seriously discredited, while the second can at best receive the Scotch verdict, not proven. In any case, natural selection must fight its own battles.

Latter day biologists have come to see clearly that the inadequacy of natural selection lies in its failure to explain the origin of the fit; and Darwin himself recognized clearly enough that it is not an originative or creative principle. It is only a condition of survival, and hence a condition of progress. But whether we conceive with Darwin that selection has acted mainly upon slight individual variations, or with De Vries that it has operated with larger and more stable mutations, any adequate general theory of evolution must explain the origin of the fit. Now, under the theory of natural selection, pure and simple, adaptation or fitness has a merely casual or accidental character. In itself the fit has no more significance than the unfit. It is only one out of many possibilities of change, and evolution by natural selection resolves itself into a series of lucky accidents. For Agassiz or Cuvier the fit is that which was designed to fit. For natural selection, pure and simple, the fit is that which happens to fit. I, for one, am unable to find a logical flaw in this conception of the fit; and perhaps we may be forced to accept it as sufficient. But I believe that naturalists do not yet rest content with it. Darwin himself was repeatedly brought to a standstill, not merely by specific difficulties in the application of his theory, but also by a certain instinctive or temperamental dissatisfaction with such a general conclusion as the one I have indicated; and many able naturalists feel the same difficulty to-day. Whether this be justified or not, it is undoubtedly the fact that few working naturalists feel convinced that the problem of organic evolution has been fully solved. One of the questions with which research is seriously engaged is whether variations or mutations are indeterminate, as Darwin on the whole believed, or whether they be in greater or less degree determinate, proceeding along definite lines as if impelled by a *vis a tergo*. The theory of "orthogenesis," proposed by Naegeli and Eimer, makes the latter assumption; and it has found a considerable number of adherents among recent biological investigators, including some of our own colleagues, who have made important contributions to the investigation of this fundamental question. It is too soon to venture a prediction as to the ultimate result. That evolution has been orthogenetic in the case of certain groups, seems to be well established, but many difficulties stand in the way of its acceptance as a general principle of explanation. The uncertainty that still hangs over this question and that of the heredity of acquired characters bears witness to the unsettled state of opinion regarding the whole problem, and to the inadequacy of the attempts thus far made to find its consistent and adequate solution.

Here, too, accordingly, we find ourselves confronted with wide gaps in our knowledge which open the way to vitalistic or transcendental theories of development. I think we should resist the temptation to seek such refuge. It is more than probable that there are factors of evolution still unknown. We can but seek for them. Nothing is more certain than that life and the evolution of life are natural phenomena. We must approach them, and as far as I can see must attempt to analyze them, by the same methods that are employed in the study of other natural phenomena. The student of nature can do no more than strive toward the truth. When he does not find the whole truth there is but one gospel for his salvation—still to strive toward the truth. He knows that each forward step on the high-way of discovery will bring to view a new horizon of regions still unknown. It will be an ill day for science when it can find no more fields to conquer.

THE TOPOGRAPHIC MAPS PREPARED BY THE UNITED STATES GEOLOGICAL SURVEY.

THE work of mapping the United States has been intrusted by Congress to the United States Geological Survey. This is the one organization whose business it is to prepare a map or atlas of the entire country, and it is now and has been since its establishment in 1879 engaged continuously on this work. So far it has surveyed about 1,050,000 square miles (exclusive of areas surveyed in Alaska), or more than one-third of the United States.

The sheets or maps forming this atlas represent areas that have been called quadrangles, whose boundaries are meridians of longitude and parallels of latitude. About 1700 quadrangles have now been mapped. These maps are published on three different scales—1 mile to the inch, 2 miles to the inch, and 4 miles to the inch. The areas mapped differ in size with the scale used, averaging 230 square miles for the first scale, 920 square miles for the second, and 3,700 square miles for the third. The largest scale is used for densely populated or otherwise important areas; the next largest for scantily inhabited, mountainous, or desert regions; the smallest for areas covered by reconnaissance surveys, especially in the Western States and Alaska. For some areas of particular importance special larger-scale maps are published.

Whatever the scale, the atlas sheets are of nearly uniform size (the paper is about 17 by 20 inches), and are all alike in general character. They show the principal natural features of the land, such as mountains, hills, valleys, and gulches; all bodies of water, such as lakes, marshes, streams, and springs; the routes of travel, such as railroads, wagon roads, and trails; all political boundaries; all cities, towns, and permanent buildings; and the names of natural and other features. They also indicate exactly the location of permanent survey monuments and bench marks whose positions and whose elevations above sea level have been determined by precise methods—monuments that are available as starting points for local surveys. In the areas covered by public land surveys they show all township and section lines as well as the boundaries of all land grants.

Each of these maps is printed in three colors, black for the cultural features, such as boundary lines, roads, railroads, houses, towns, and cities, and for the names of all things represented; brown for the topography, or the element of elevation, indicated by contour lines showing the heights of all parts of the area above sea level; and blue for the water—the rivers, lakes, and the sea, and its bays and inlets.

BUOYS AND BEACONS.

THEIR VARIOUS FORMS AND PURPOSES.

BY MAX BUCHWALD.

Buoys are anchored floating bodies, usually hollow, and of various markings. Beacons are small skeleton towers erected on shoals or on the shore. Both buoys and beacons are used to supplement lighthouses and lightships by marking channels in harbors. For night service they may bear lights or bells or whistles.

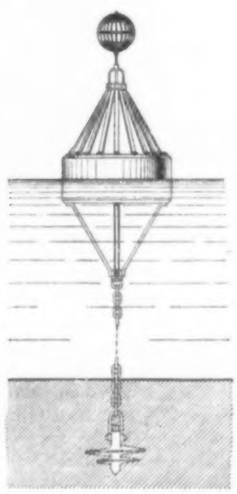


FIG. 1.—BEACON BUOY.

Beacons of stone were used in ancient times, but buoys appear to have been first employed, at the mouth of the Elbe, in the beginning of the fourteenth century. In Great Britain, France, Russia, and the United States, the position, form, and color of buoys and beacons have long been rigidly prescribed by law. In Germany each coast State had its own regulations

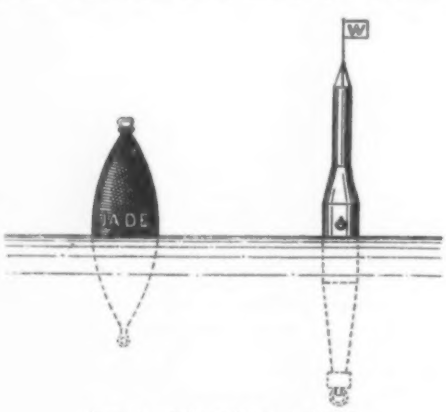


FIG. 2.—CHANNEL BUOYS.
CONICAL BUOY. SPAR BUOY.

until 1889, when a uniform system was adopted. The maritime nations of the world, however, have not yet agreed on a uniform method of marking channels, though wrecks are universally indicated by green signals.

The German system, in brief, is as follows: The right side of the channel, as seen from an incoming

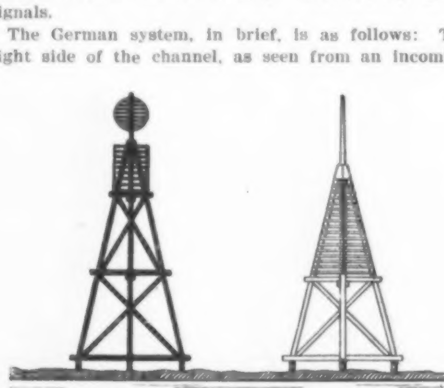


FIG. 3.—CHANNEL BEACONS.

vessel, is marked with red, the left side with black buoys. A buoy striped red and black indicates a bifurcation of the channel and may be passed on either side. The outermost buoys are surmounted by skeleton pyramids and are designated as beacon buoys. (Fig. 1.) Similar buoys are placed at forks and shoals, and bell, whistling, and light buoys are also of this construction.

Spar buoys and spar beacons mark the right side of the channel, as seen from an incoming ship, and are painted red. Conical buoys and beacons without spars mark the left side and are painted black (Figs. 2 and 3).

Half-submerged spherical buoys indicate mid-channel if striped red and black, and cable crossing if

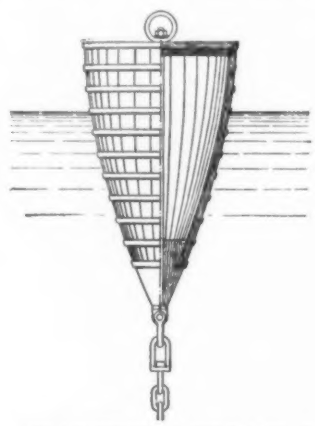


FIG. 4.—FLAT-TOPPED WOODEN BUOY.

painted green. Flat-topped buoys (Fig. 4) are used to distinguish adjacent channels and sometimes instead of spar buoys if the water is too shallow for the latter.

Wrecks are marked by green, quarantine limits by yellow buoys, barrel shaped, cylindrical, conical, or flat-topped, or by ordinary casks painted in the proper colors.

Shoals outside of the channel are indicated by white or black and white striped spar buoys, beacon buoys, or beacons. Individual buoys are distinguished by their tops and by white numbers, words, and letters (for example, T, meaning telegraph), painted on the

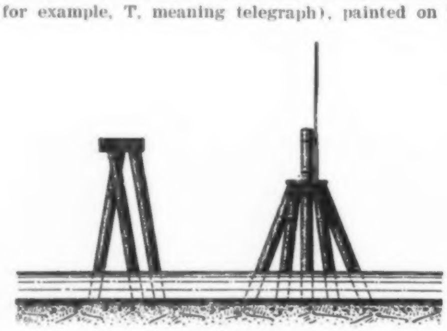


FIG. 5.—PILES TO LEFT AND RIGHT OF CHANNEL.

sides. The top may be of any color or form, with three exceptions. A cross, a short vertical cylinder, and a combination of two equilateral triangles are reserved for special purposes.

For marking inner and subordinate channels beacons may consist of one or more piles (Fig. 5) or poles or saplings bearing branches, brooms, flags, etc. (Fig. 6.)

Let us now examine more closely the construction

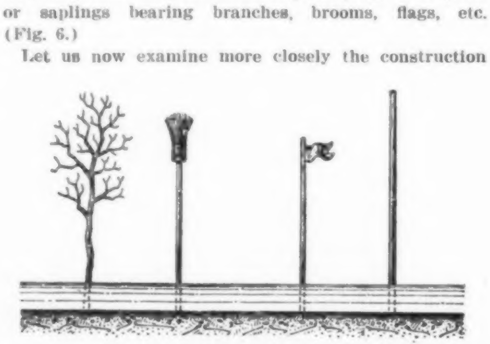


FIG. 6.—POLES AND SAPLINGS TO LEFT AND RIGHT OF CHANNEL.

of buoys and beacons, beginning with the former. The first buoys were ordinary casks, and even buoys of other forms were for a long time built up of stout wooden staves and heavy iron hoops. (Fig. 4.) This construction is now abandoned, and even the buoy made of iron plates riveted together is fast becoming obsolete. Most hollow buoys are now welded. A welded buoy need not be divided into compartments as a large wooden or riveted buoy must be, to provide against leakage, and it can be ridden down by large vessels without springing a leak. All large iron buoys, whether riveted or welded, are provided with man-

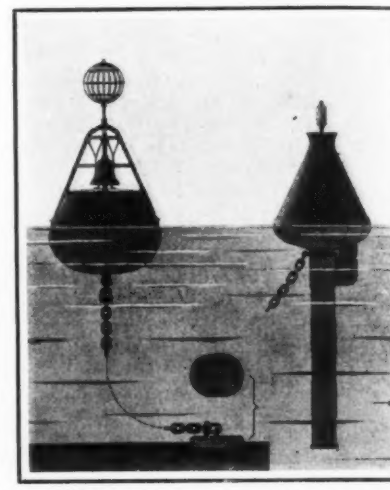


FIG. 7.—BELL BUOY AND WHISTLING BUOY.

holes for examination and rings for hoisting and towing.

The form and size of buoys are conditioned partly by the regulations given above and partly by the depth of water, the force of the waves and current, the degree of stability required and the presence or absence of ice. The displacement must also be sufficient to support the required length of anchor chain and to prevent excessive submergence by wind and waves. The beacon buoys which are anchored in deep water are of considerable draft and great stability. In the best type, as in the whistling buoys described below,

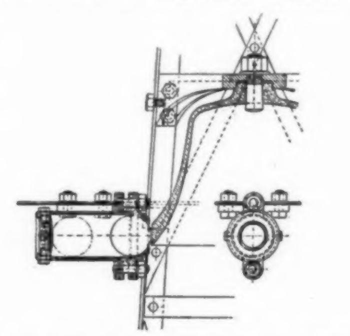


FIG. 8.—PINTSCH BELL-RINGING DEVICE.

a long tube, open at its lower end, extends downward from the bottom of the buoy. In shallow water stability is assured by adding cast-iron counterpoises, by making the bottom of the buoy flat or arched and very broad, or by riveting a broad and shallow cylinder to the bottom, so that the buoy cannot fall over, even if it is deposited on the harbor bottom at very low water.

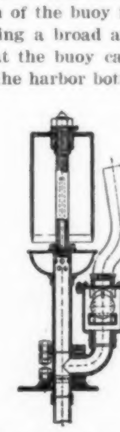


FIG. 9.—WHISTLE OF A BUOY.

Injuries caused by waves and ice are minimized by the conical shape of the buoy and its comparatively small area at the water level. Modern iron beacon-buoys have capacities of from 5 to 12 cubic meters (176 to 424 cubic feet), weigh from 3 to 6 tons, and measure 3 meters (10 feet) and more in diameter.

Buoys used for marking channels are much smaller. The anchor chain is made of long links, with several swivels. It is either attached to the center of the bottom of the buoy by a swivel or, preferably, is wrapped like a festoon around the buoy, which it maintains nearly vertical at all times. In tube buoys the chain is often attached to one side, and on the other is placed a fixed rudder which always sets itself parallel with the current and prevents the tube from

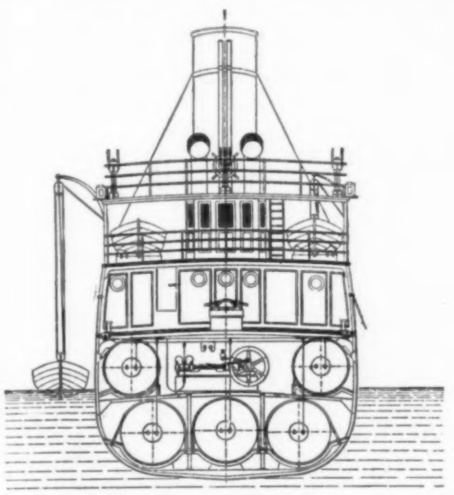


FIG. 10.—SECTION OF A GAS TRANSPORT.

fouling the chain. (Fig. 7.) The length of the chain should be twice the depth of smooth, and three times that of rough water. The old practice of attaching the chain to a large stone or to a small ship's anchor or a pair of such anchors is falling into disuse. Mushroom anchors or, in soft ground, blocks of concrete or

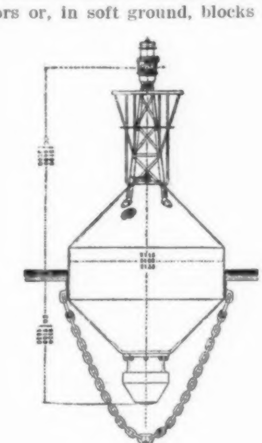


FIG. 11.—PINTSCH LIGHT BUOY.

cast iron, are now commonly used. Blocks weighing from 1 to 4 tons are used for the largest buoys. In hard ground a short screw about 3 feet in diameter is sometimes driven to a depth of from 3 to 6 feet by means of a long wrench, or key, applied to its square head. (Fig. 1.)

None of the buoys described above is of any utility at night or in foggy weather. For these conditions

FIG. 12.—SHOAL WATER LIGHT BUOY.

bell buoys, whistling buoys, and light buoys have been devised.

Bell buoys are used chiefly on the English coast. The apparatus (Fig. 7) consists of a large buoy bearing a bronze bell. The bell is mounted rigidly in a strong frame attached to the buoy and is struck by the freely suspended clapper as the buoy is rocked by the waves. Bells weighing more than 2 tons are used in some buoys, but the usual weight does not greatly exceed 200 pounds. In modern bell buoys the single clapper hung inside the bell has been superseded by

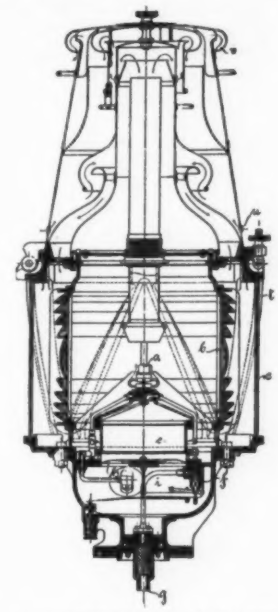


FIG. 13.—PINTSCH GAS LANTERN.

three or four clappers placed outside it. This arrangement insures the ringing of the bell by comparatively slight oscillations of the buoy. But even bell buoys of this type are often silent in foggy weather, when the sea is usually very calm.

The Pintsch Company, of Berlin, has constructed a

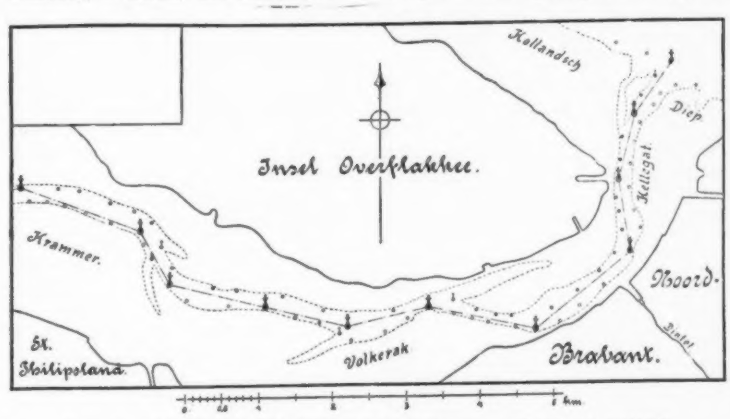


FIG. 16.—BUOYS MARKING CHANNEL OF A DUTCH RIVER. ⸸ INDICATES A LIGHT BUOY.

novel sounding apparatus which is brought into action by the slightest movement of the buoy. It consists of three iron cylinders, each containing a steel ball,

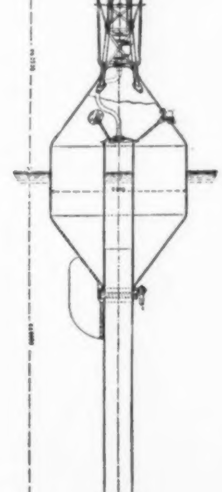


FIG. 14.—WHISTLING BELL BUOY.

which are arranged symmetrically around the bell. The ball is small enough to roll easily in the cylinder, between a rubber disk at the outer end and a rubber ring at the inner and open end, and to project through the ring far enough to strike the bell. (Fig. 8.)

Whistling buoys have generally been found more satisfactory than bell buoys. The whistling buoy was invented by the American Courtenay in the early seventies. It is provided, as shown in Fig. 7 (right), with a wide tube, open at the bottom, and terminating above in a whistle and an inlet valve. (Fig. 9.) As the bottom of the tube is 20 or 30 feet below the surface, where the effects of wave motion are inappreciable, the water stands at mean sea level inside the tube. Hence, when the buoy is lifted by a passing wave air is drawn in through the valve, and when the

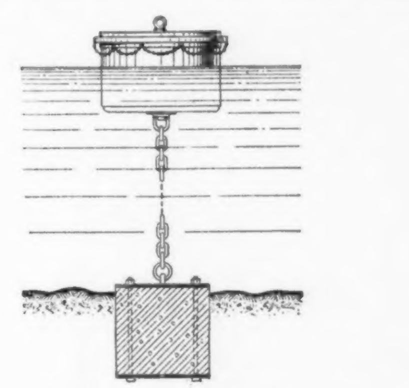


FIG. 15.—ANCHOR BUOY.

buoy sinks this air is forced out through the whistle. The sound is audible to a great distance, which increases with the height of the waves. The closing of the tube by barnacles, etc., can be effectually prevented, as experience has proved, by the addition of chains dangling loosely inside the tube.

We now come to the most important and commonest special type of buoy, the light buoy, the introduction of which is due to Pintsch Brothers, of Berlin, celebrated for their successful application of compressed oil gas to the lighting of railway trains. In the extension of this method of illumination to buoys and beacons the fundamental idea comprised the manufacture of gas at suitable points on the coast, its conveyance in compressed st-te to points of consumption, its transfer to small containers and its combustion in waterproof and stormproof lanterns, so constructed that the lights should require no attention except an occasional recharging with gas. The only gas suited

FIG. 17.—SETTING A BUOY.

to this use is the so-called oil gas, made from lignite tar, shale oil, crude petroleum, or petroleum residues. This gas can be compressed to ten atmospheres without losing more than 20 to 30 per cent of its original illuminating power, which is about thrice that of ordinary coal gas, and it neither clogs the b-rner with **residues nor blackens the lantern with smoke. The**

compressed gas is conveyed to the buoys in specially constructed barges or steamers, many of which are equipped with machinery for towing, raising, and lowering, so that they can be used for placing, as well as for charging buoys. Each of these vessels carries a number of welded steel tanks, filled with gas at a pressure of ten atmospheres, and a pump by which gas can be forced from one tank into another to make good the loss of pressure caused by charging the buoys. The latter are charged to pressure of seven or eight atmospheres by simply connecting them with the tanks by means of pipes. Fig. 10 shows a transverse section of a gas steamer in the British service, which carries

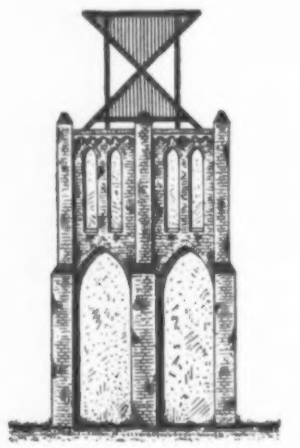


FIG. 18.—STONE BEACON AT BORKUM.

300 cubic meters (over 10,000 cubic feet) of compressed gas.

A light buoy differs from an ordinary beacon buoy only by the addition of a lantern and an adit cock, as the hollow buoy itself serves as a gas holder. Fig. 11 illustrates a deep-water type that is made in capacities of 5, 7.5, and 10 cubic meters (176, 264, and 353 cubic feet) and weights of about three, four, and five tons. The height of the lantern above the water is from 10½ to 12 feet. Stability, which is especially necessary for light buoys, is furnished by a cast-iron counterpoise suspended below the buoy by chains.

Fig. 12 shows a large shoal-water light buoy. The gas burns night and day for two, three, or four months, according to the size of the burner and the capacity of the buoy. A large light buoy costs about $2,000, one of medium size $1,500. The lantern of a light buoy must shine continuously for months, through wind and storm, without any attention. The Pintsch lanterns, which satisfactorily meet these high requirements, are made entirely of copper and bronze, in two sizes, with Fresnel cylindrical lenses of 4 and 8 inches diameter. Fig. 13 shows a vertical section of the lantern. The gas enters at *g* and passes through a dust catcher of the regulator *i* which reduces the high and gradually diminishing pressure to a constant pressure of 60 or 70 millimeters (about 2.5 inches) of water. The gas enters the regulator through the conical valve *f*, the plug of which is connected with the flexible

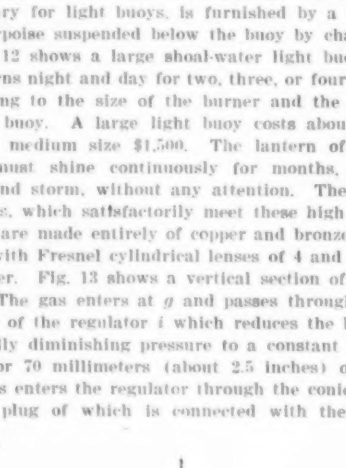


FIG. 19.—WOODEN BEACON AT CUXHAVEN.

leather top of the regulator in such a manner that inflow of gas is diminished when the pressure rises. From the regulator the gas flows into the chamber *e*, the function of which is to prevent a sudden interruption of the stream, and the consequent extinguishment of the light, when the buoy is subjected to violent shock. Above this chamber is the burner *a*, in the focus of the cylindrical lens *b*, which is protected by an enveloping cylinder of wire glass, *t c*. Burners with three, five, and seven small flames are used, as well as Argand burners, ¾ inch in diameter. Air is admitted at *u* and the products of combustion escape at *v*.

Neighboring light buoys and beacons are distinguished from each other by the color (white, green, or red) and the character (steady or intermittent) of the light. The colored lights are produced by surrounding the flames with colored glass cylinders. In the intermittent lights the chamber *e* is replaced by an apparatus which periodically cuts off the supply of gas from the main burner, which is relighted by a small permanent flame. Any desired period of intermittence may be used and thus an additional means of distinguishing lights is given. Intermittent lights, of course, consume less gas than steady lights. In clear weather the brightest lights can be seen for 10, 5.5, or 4.5 nautical miles, according as the color is white, red, or green.

Of devices for automatically extinguishing the light at dawn and relighting it at dusk, thereby effecting a great saving of gas, the most interesting includes a small permanent flame, and a strip of selenium, the increased conductivity of which in daylight enables a current from a galvanic cell to energize a magnet and shut off the main stream of gas. At night the gas is turned on by another electromagnet which is caused to act by the increased resistance of a second selenium cell.

Although oil-gas buoys are only thirty years old—they were first used to mark the St. Petersburg-Cronstadt channel in 1877 and experimentally introduced in English waters in 1878-9—their value has been so rapidly and widely recognized that in 1900 nearly 800 were in use on the coasts of various countries. Attempts have been made to light buoys by electricity, but the only electrical system of practical importance is the group of buoys placed in the harbor of New York in 1889. Each buoy carries a powerful incandescent lamp, without lenses, and all the lamps are connected by cables to an electric plant on shore.

Combined light and whistling buoys are used to some extent, especially in Danish waters. (Fig. 14.)

Anchor buoys are employed for the mooring of vessels in harbors which are too deep for piles to be driven. They are usually flat-topped and are secured by very heavy chains and anchors. Fig. 15 shows an anchor buoy in the harbor of Kiel which is chained to a block of concrete, 6.5 feet broad and about 15 tons in weight, imbedded in the harbor bottom.

In regard to the emplacement and control of buoys it must be remembered that, in general, the buoys of a harbor form a connected system which marks all navigable channels through their entire length. Fig. 16 gives a simple example and also illustrates the emplacement of light buoys at bends in the channel. All buoys, and especially iron buoys, must be kept well painted, and riveted buoys must be tested occasionally with a water pressure equal to one atmosphere. For this purpose they must be hauled in and replaced by reserve buoys, and in many northern harbors the large buoys are replaced in winter by small ones which are less seriously damaged by ice. These operations are performed by a buoy tender which, as we have seen, may also be a gas transport.

Beacons are of two kinds, channel beacons and shore beacons or landmarks. The former are usually small skeleton towers of wood (Fig. 3) or of iron (Fig. 21), while landmarks, toward which distant incoming vessels are expected to shape their course, are commonly much higher towers of wood, iron, or stone. The height of the stone beacon shown in Fig. 18, including the wooden hour glass signal on top, is 66 feet. Landmarks of this massive construction are common on the Frisian Islands. A stone beacon 20 feet high, resting on a concrete foundation more than 20 feet in diameter, was erected thirty years ago on submerged rocks between Corsica and Sardinia. Wooden landmarks abound on the German coast. The Cuxhaven "ball beacon" (Fig. 19) is nearly 100 feet high. Like all conspicuous beacons on the North Sea coast, it was erected in 1871, as the former beacons had been destroyed to prevent their serving as landmarks to an attacking French fleet. Many of the large beacons erected on the shoals at the mouths of the Elbe and Weser have shelters stocked with food, water, wine, and flags of distress for the benefit of shipwrecked persons who may succeed in reaching them.

Iron beacons are of recent introduction. The oldest, probably, is the Memel beacon, 125 feet high, which was erected in 1852.

Many harbor mouths, especially in the Baltic, are provided with signaling beacons. The upper part of the beacon is a mast, bearing a ball or a flag, which can be swayed to right or left for the purpose of giving sailing directions to vessels without pilots.

The use of lights or fires on land beacons is no new thing. A coal fire was lighted nightly on the old wooden tower shown in Fig. 20. The tower is 75 feet high and was erected about the middle of the eighteenth century. In general, however, lanterns containing candles or oil lamps were preferred to fires, as they required tending only once daily. Only readily accessible beacons could be lighted by this method, and when the Pintsch system was applied to the others its use proved so advantageous that it was rapidly extended, even to lights on inland waters, where it dispenses with the services of a light keeper. Two hundred such lights were in operation in 1900. Auer burners are used in some twin light beacons, and experiments are being made with acetylene. Some beacons are lighted at night and extinguished at day-break by means of clockwork and auxiliary permanent flames. If the gas container is not placed on or in the beacon, but further inshore, as is the case with

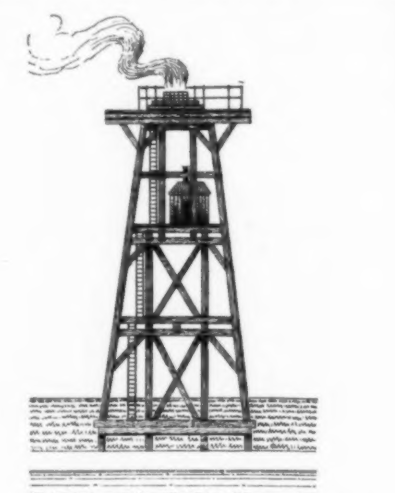


FIG. 20.—OLD FIRE BEACON AT NEUWERK.

beacons on exposed breakwaters, no clockwork is required, as the gas can be turned on and off. Offshore beacons and many shore beacons receive their gas from the gas transports, a permanent pipe making connection with a convenient point on the shore if the beacon is too far inland to be served directly from the steamer.

Fig. 21 shows a modern iron light beacon on the lower Weser. Many lights, however, are supported by towers of wood and stone, some by piles, and a few by wrecks.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

WELL WATERS OF SOUTHERN LOUISIANA.

THE oft-repeated popular statement that the waters of the Mississippi supply the wells in southern Louisiana has been to a large extent, if not entirely, disproved, according to Prof. Gilbert D. Harris, in a report on the underground waters of the region, published by the United States Geological Survey as Water-Supply Paper No. 101. "Certainly," says Prof. Harris, "no veritable river is leaving the Mississippi in its lower reaches to force its way laterally for long distances underground," and for the source of supply of the many hundreds of 10-inch and 12-inch wells that yield almost rivers of clear, cool water search must be made in other directions. The Gulf has also been cited to account for the apparently immense quanti-

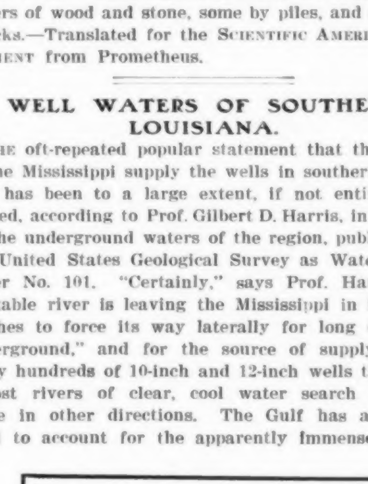


FIG. 21.—IRON LIGHT BEACON IN THE WESER.

ties of water beneath the surface of southern Louisiana, and that there is a more or less intimate connection between the fresh waters under the ground and the salt water of the Gulf there can be no doubt, for witness is borne to it by the appreciable rise in the level of water in wells not far from the coast during high tides or long-continued southerly winds, and also by the fact that when such wells are pumped vigorously the water level falls below tide, but resumes tide level when pumping is stopped. A varia-

tion in the height of water in some wells coincident with that in a neighboring body of water in which there is perceptible tide was long ago recognized by members of the Louisiana State Geological Survey and others, and has also been observed in wells located near the seacoast in many other regions. But that there is no underground current from the Gulf landward is evident from two facts pointed out by Prof. Harris: (1) When pumping in the affected wells ceases for a few hours the water level quickly rises above the tide, and (2) any water derived from the Gulf would possess a saltiness that has not thus far been recorded in any deep well in this region.

The controlling factors in the underground water conditions are apparently the surface features, which have a marked influence on the rate of underground as well as overground flow, the character of the rock formations that hold the water, and the heavy rainfall. The annual precipitation in the southern part of the State is about 55 inches. This means that each acre of land receives each year more than double enough rain water to irrigate it properly if planted in rice. Of course much of this water is lost, so far as agricultural purposes are concerned, by flowing away in surface streams; but that much of it also is absorbed by the soil and is transported to distant places through underground porous layers is evident from the existence of many satisfactory deep and artesian wells throughout the southernmost parishes of the State.

FISHES AND THE MOSQUITO PROBLEM.

THEIR SERVICEABILITY AS MOSQUITO EXTERMINATORS.

BY WILLIAM P. SEAL.

It may be safely stated that all small fishes, whether of small species or the young of the larger kinds, will be found to devour mosquito larvæ with avidity, but notwithstanding this fact, observations made in aquaria are of little value as indicating the usefulness of a species under natural conditions. The natural habits of the species are the only safe guides. Some species range in the quiet open water, while others are always to be found in the currents; some live among aquatic or semi-aquatic plants; some are solitary; some gregarious; some are wholly carnivorous, others herbivorous, or largely so, and others again are omnivorous. Some are sluggish or lethargic in habit, others apparently always in motion. Then again there are those that feed on the bottom, others that seek for food in the currents, and some that seem only to wander about stealthily without fixed habits, but taking whatever comes in their way. There is another class which are surface feeders—the top minnows. These are continually skimming the surface of the water, forcing themselves through, over, and among aquatic plants that lie in feathery masses at the top, though they do not fully exhibit this habit within the restricted limits of the aquarium.

Thus it will be seen that we have a great diversity of characteristics to consider in estimating the value of a species for our purposes.

The young of many of the smaller food fishes, such as the pike and the common sunfish—generally known as "pumpkin seed"—are very destructive to the smaller species most useful as mosquito destroyers, but in general they are not to be found where mosquitoes breed. There are in fact only a comparatively few species of fishes that can be considered directly useful in relation to the mosquito problem. This, of course, does not militate against the fact that if it were not for the innumerable hosts of fishes and insects inhabiting our larger waters, thus preventing the more general breeding of the mosquito, human life would be rendered unendurable. In that larger sense all of them have a value.

In a large number of observations it was found that if say a dozen tubs were arranged side by side, and eleven of them were stocked with fish, the eggs of the mosquito would appear only in the uninhabited twelfth. It might appear at first thought that the fishes had probably eaten the mosquitoes that had attempted to deposit their eggs in the inhabited tubs. But it is only reasonable to suppose that in the long ages they have acquired that instinctive power of discrimination—so general in the animal kingdom—which would lead them to deposit their eggs where there would be the least danger of their destruction. It would require no greater exercise of inherited instinct than that which incites the cunning and celerity which enables them to avoid a quick slap of the hand. Other observations also lead to the belief that mosquitoes, except *Anopheles*, systematically avoid depositing their eggs in waters which are already inhabited by fishes and aquatic insects, unless there are in such places masses of grass or other plants, bushes, or brush, all of which afford some measure of protection.

The stocking of natural waters with fish for mosquito destruction would, of course, be subject to the limitations imposed by nature, as in fish culture. Only practical observation and experiment will determine to what degree it can be made successful, or how far it may be needful. Fishes exercise choice in the selection of their habitats, and will if possible migrate from such as do not fully meet their requirements, or which contain too great a menace to their safety. Their enemies are everywhere abundant. Yet the limited geographical range of a species is not proof positive that there are barriers to its extension. In the egg and fry stages the destruction of fishes is very great from the voracity of their own kind. Then they are favorite food for water insects and their larvæ, and even of forms of life as low as the hydra. The later destruction by frogs, snakes, turtles, birds, etc., is also very large. The great fecundity of fishes is indicative of their great mortality.

It becomes a question, therefore, to what extent nature can be aided or reinforced in this respect in natural waters. To doubt that there are possibilities in the introduction or transfer of small species of fishes to other waters for specific purposes would be to discredit the fundamental principles of fish culture.

It seems to the writer that the providing of fishes for stocking waters infested by mosquitoes with fishes suitable for their destruction, or of experiment in this connection, is as properly the function of fish commissions as that, at least, of stocking waters for purposes of sport and recreation, for trout culture has no economic value at all commensurate with the outlay involved, and benefits only a very few. There is no good reason why legislation should not be invoked in this direction, as the benefits resulting will be shared by all alike, without regard to race, color, or condition of pocketbook.

There is one class of waters to which little attention has as yet been given, which might be not inaptly termed the incubators and brooders of *Anopheles*. These are the ornamental plant ponds, which have become wonderfully beautiful and attractive landscape features of our public parks and great private estates. It is in these places that *Anopheles* find to perfection the conditions that foster and protect them, no doubt looking upon them as having been specially developed for their comfort and happiness. For *Anopheles* larva may be found in abundance wherever there are plants to shelter them. And not only do they lie concealed above or among the plants, but they assimilate so closely to their surroundings in color that only the experienced can discern them. They may be found in the grasses or sedges that margin a rapid-running brook, among the cat-tails and flags, the water poppies and water hyacinths, over the masses of feathery plants reaching to the surface in the ornamental pond or lake, and even in the concavity of the floating dead leaf, or among the drift of seeds and dead twigs where the water of streams is sluggish. Thus the one species of mosquito in our northern waters having a malignant character is the best protected, and has attracted the least attention in the work of extermination. This genus does not appear in sudden irruptions of "clouds," as does the *Culex* shortly following a heavy rainfall. But its breeding is going on continuously and insidiously, so securely hidden and protected that comparatively few are destroyed in the larval stages. And so much more stealthy and undemonstrative are the attacks of the adult, that they more easily escape destruction also.

As a destroyer of *Anopheles* the writer has for several years advocated the use of *Gambusia affinis*, a small viviparous species of fish to be found on the South Atlantic coast from Delaware to Florida. A still smaller species of another genus, *Heterandria formosa*, is generally to be found with *Gambusia* and is of the same general character. The females are about one inch long, and the males three-quarters of an inch. Both of these species are known as top-minnows, from their habit of being constantly at the surface, and feeding there. The conformation of mouth, the lower jaw projecting, is evidence of their top-feeding habits. Both of these species are to be found in great numbers in the South in the shallow margins of lakes, ponds, and streams in the tidewater regions wherever there is marginal grass or aquatic and semi-aquatic vegetation. They are also to be found in shallow ditches and surface drains where the water is not foul, even where it is but the fraction of an inch deep. In fact, if any fishes will find their way to the remotest possible breeding places of the mosquito, it will be these. And they are the only ones, so far as the writer's observation goes, that can be considered useful as destroyers of *Anopheles* larvæ.

Gambusia is found in the Ohio Valley as far north as southern Illinois, where the winter climate must be at least as severe as that of the coast of New York and New Jersey.

Dr. Hugh M. Smith, Deputy U. S. Fish Commissioner, informed the writer that he had examined the stomachs of several hundreds of *Gambusia* in the Chesapeake Bay and Albemarle Sound waters, and had found the contents to be principally mosquito larvæ.

In the year 1901 the writer suggested to Dr. Smith the desirability of experiment with *Gambusia* in this connection by the U. S. Fish Commission, but was informed that such an experiment would be foreign to the functions of the Commission; that it would more properly belong to the Entomological Division of the Agricultural Department. Recently, however, it has been stated in the newspapers that the Commission has sent a messenger from Texas to Hawaii with several thousand *Gambusia* and an allied species, for the purpose of stocking the irrigating canals and ditches with them as mosquito destroyers, thus, apparently at least, showing a practical appreciation of the suggestion. Dr. Smith has since confirmed the report in a letter to the writer.

The experiment in question has been carried on in a small way for three years or more by Prof. John B. Smith, and the further experiment of acclimating *Gambusia* and *Heterandria* has been made during the past winter with apparently favorable results.

While, as has been stated, all fishes have some measure of usefulness, if only in the way of deterrent effect, there are only a few species likely to be found in waters in which mosquitoes breed. The most important of these are the gold fish (introduced), several species of *Fundulus* (the killifishes), and allied genera, three or four species of sunfish, and the roach or shiner and perhaps one or two other small cyprinoids In addition there are a few sluggish and solitary species like the mud-minnow (*Umbra*) and the pirate perch (*Aphredoderus*). The sticklebacks have been mentioned in this connection, but the Atlantic coast species, and probably the entire family, are undoubtedly useless for the purpose, being bottom feeders, living in the shallow tide pools and gutters, hidden among plants, or under logs and sticks at the bottom, where they find an abundance of other food.

In the salt marshes there are myriads of killifishes running in and out and over them with each tide, while countless numbers of other and smaller genera such as *Cyprinodon* and *Lucania* remain here at all stages of the tide. So numerous and active are all of these, that there is no possibility of the development of a mosquito where they have access.

Of the killifishes two species, *Heteroditus* and *Diaphanous*, ascend to the furthest reaches of tide flow, but it is a question as to whether they would prove desirable for the purpose of stocking land-locked waters, since they are a good deal like the English sparrow, aggressive toward the more peaceable and desirable kinds. Even *Cyprinodon*, which would at first thought be a valuable small species in this respect, is viciously aggressive toward goldfish and no doubt all other cyprinoids. It is so characteristic of all the cyprinodonts, that they can only be kept by themselves in aquaria. They are the wolves or jackals of the smaller species.

The writer has come to the conclusion, after many experiments in both tanks and ponds, that a combination of the goldfish, roach, and top-minnow would probably prove to be more generally effective in preventing mosquito breeding than any other. The goldfish is somewhat lethargic in habit, and is also omnivorous, but there is no doubt that it will devour any mosquito larvæ that may come in its way, or that may attract its attention. The one great objection is that they grow too large, and the larger will eat the smaller of them. That is one of the drawbacks to goldfish breeding. There is no danger of overpopula-

tion, but there is of the reverse. Whether or not it is the same with the roach, they are never excessively numerous, although no doubt the most abundant and most widely distributed of the Cyprinidæ. They are largely the prey of predaceous fishes, and never approach to the numbers of the killifishes. But at all events they are not lethargic like the goldfish, being on the contrary one of the most active of the family, and equally at home in flowing or stagnant water. The roach is always in motion, back and forth, and around and about, on a never-ending patrol.

The top-minnow would supply the deficiencies of the other two species, and in combination they should very thoroughly populate any waters not already stocked with predaceous kinds, and exercise an effective control. One of the great difficulties in the case is that there are dozens of kinds of insect larvæ besides those of the mosquito, and other forms of life as well, which are natural and possibly preferred food of the fishes, thus requiring an enormous population to devour them all.

The larvæ of gnats, midges, ephemera, and other flies and insects which breed in the water, as well as the many small crustaceans, afford a menu of delicacies that would stagger a gourmand. The above combination of mosquito destroyers might be supplemented by two small species of sunfish, *Enneacanthus obesus* and *E. gloriosus*, which live among plants and would be a check on larvæ other than the mosquito. The black-banded sunfish, *Mesogonistius chaetodon*, would also be desirable for this purpose, if they were not so difficult to obtain in large numbers. One or both species of *Enneacanthus* can be found wherever there are aquatic plants. The above-mentioned five species in combination seem to be the most suitable for pond protection of all those which are known to thrive in still water, and which in any degree possess the desired qualities. As has been stated, the killifishes would probably be found to be undesirable. In their natural habitat, the tidal streams and great expanses of small marsh, their efficiency is unquestioned.

There are many places at the seashore where there are swales or hollows filled with grasses and bushes, which in periods of rainfall become breeding places for the mosquito, especially of *Anopheles*. If these places are stocked with fish, the result is that when they dry up the fish perish, and the operation must be repeated after each filling.

The writer has suggested digging holes about four feet square down through the turf into the sand stratum in the deepest part. Two feet is usually sufficient to secure a constant water supply where the fish can exist until the hollow is again rain-filled. *Cyprinodon* and *Lucania* would be desirable for such places, and they are to be found everywhere in the ditches and tide pools on the flats.

To add variety to the treatment of the subject, it might not be amiss to suggest that there is a fish, *Anablops*, inhabiting the fresh waters of South America, which seems to be specially adapted to this purpose. To quote: "These small fishes swim at the surface of the water, feeding on insects, the eye being divided by a horizontal partition into a lower portion for water use, and a portion for seeing in the air."

USE OF SUBMARINE SIGNAL BELLS IN FOG.

THE Zealand Line, whose vessels run between Flessingue, Holland, and Queensborough, England, seems to be the first to employ submarine bells for signaling, especially during fogs. The two jetties of Flessingue have been provided with fog signals for some time past, but nevertheless the vessels of the line sometimes had great difficulty in finding the entry of the port during fogs. The new system of signal bells is claimed to overcome this disadvantage and to work in an excellent manner. The apparatus consists of a bell at the shore end in which is placed a spring in such way that when the spring is set free it gives a strong action upon a striker for ringing the bell. Thus the sound is clear and penetrating and it is perceived at great distances. The bell is mounted so that the circle in which the sound waves are propagated lies between the two jetties and in this position the effect is strong, while outside of it there is but little sound heard. The vessel can thus find the entry of the port. For this purpose the apparatus mounted on board consists of receiving devices, telephones, and battery. The receivers are fixed near the forward end of the ship and on each side of it and are placed in watertight iron boxes, below the water line. Cables connect them with the battery and with the captain's bridge, where there are two telephones placed. A communicating switch allows of using one or the other of the receivers on either side of the vessel. The sound of the shore-bell is heard very clearly and by means of the commutator the observer can throw on one or the other receiver so as to determine by the relative intensity of the sound whether he is at the middle part or not, and can steer the vessel accordingly. This sound-signaling apparatus has been described in the SCIENTIFIC AMERICAN.

ENGINEERING NOTES.

Consul-General Robert J. Wynne, of London, reports that according to Lloyd's Register the vessels under construction in the United Kingdom at the end of March, 1908, were 847,501 gross tons, against 1,306,087 at the end of March, 1907, a decrease in a year of 35 per cent, of which 100,000 gross tons occurred during the last three months of the year. The present depression extends to every shipbuilding center in the kingdom with the exception of Barrow.

Alfred Christensen has submitted to the Danish government a scheme for a canal across the northern part of the peninsula of Jutland, making large use of the Liim Fiord, which passes into the peninsula from the Kattegat for a considerable distance inland. The canal, as planned by Mr. Christensen, who applied for a concession to undertake the work, would have a depth of 26.25 feet and would probably secure a large part of the traffic between the North Sea and the Baltic. Dues would be imposed on all large vessels using the canal, and, while the concessionaires would provide the funds for executing the works, they would be willing to arrange for the state to acquire a share in the undertaking.

Consul Joseph I. Brittain reports from Prague that a recent issue of an Austrian journal gives an account of an automatic money assorter, which is thus described: The inventor claims that it will assort metal coins which have been thrown together regardless of their denominations, placing each denomination in a separate basket. The various coins are thrown indiscriminately into a funnel at the top of the machine, and from the funnel they slide downward, alighting on a spiral track. This track has a protecting edge or raised border containing slits corresponding to the various sizes of the coins. As the coins of various denominations glide downward onto the track, through some peculiar mechanism of the machine they pass through the slits corresponding to their various uses, entering their respective baskets at the bottom of the machine.

According to the Engineering Record, an interesting salvage operation was carried on in the River Mersey, England, in raising the coaling barge "Pensarn," which is fitted above its flat deck with a steel tower 96 feet 6 inches high, from which cantilever arms project so as to reach over the hatchways of vessels. The usual practice of calking the defective seams, sealing the hatchways, and then pumping out was not followed, because, as stated in The Engineer, London, the weight of 16 feet of water above the flat deck was too great for it to support. The Liverpool Salvage Association, which did the work, built a cofferdam 50 feet long and 20 feet deep on the deck, surrounding the hatchways and the steel tower, and after calking the seams, both the cofferdam and the hold were pumped out at the same time. The cofferdam was built in 6 x 20 foot sections, the lower ends of which were bolted to a log base which the divers had previously secured to the deck. The sections were built on shore and floated to place.

At a meeting of the Society of Engineers, Mr. Robert H. Smith, em. professor of engineering, read a paper on "A New Design of Gear Teeth, to Minimize Waste of Power and Wear." The author enumerated ten kinds of excellence in the teeth of wheels, only two of which influenced the orthodox cycloidal and involute designs. Besides uniformity of velocity ratio and strength, the other points of consequence were obliquity of action, number of contacts, smallest practicable number of teeth, undercutting, sharpness of outline at shoulders, frictional waste of power, abrasive waste of material, change from correct shape by wear. He explained the advantages of short teeth, and denied that the thrust could be effectively divided between two contacts. It was, however, essential that contact should begin before the previous contact finished. In the author's new design the contact lasted 1.12 times the pitch with two 12-teeth pinions gearing with each other, and 1 1-3 times the pitch when two very large wheels are in gear, the addendum of the tooth being made one-fourth of the peripheral pitch. The author then gave a simple formula for the frictional waste work of toothed gear, and calculated that of his new design in an average case to be in the ratio of 106 to 180 to that of ordinary involute teeth. The leading aim of the new design was to combine small obliquity of thrust with avoidance of sharp curvature in the outline. The touching face of the one tooth should have a radius of curvature only little less than that of the flank of the tooth geared with it; in other words, the "closeness of fit" between the two should be as great as possible. This prevented the squeezing of the unguent out from between the bearing parts, increased the effective width of bearing surface, and diminished the actual intensity of pressure. The sharpness of outline at the shoulder increased with decrease of obliquity of action, and the actual design was a compromise between these opposing influences such as yielded maximum efficiency, and also secured a substantial increase of strength.

TRADE NOTES AND FORMULÆ.

Ferric Phenolene.—This is a disinfecting powder for stables, sewers, privies, cesspools, drains, etc. Mix thoroughly 30 parts by weight of animal oil (oleum animale fœtidum) and 70 parts of ferric sulphate. A pulverulent mass will be obtained. The mixing of the two constituents is performed mechanically by vigorous stirring in a stirrer.

To Produce Artificially Matured Cigars.—Boxes of cigars are laid on a grating or gridiron over a trough or vessel containing calcium chloride in powder or ferrous chloride or other substance possessing a strong attraction for water. A few sheets of blotting paper are placed at the bottom of the trough to absorb the moisture, and the boxes are closed. The damp air in the boxes draws the moisture out of the cigars, which are quickly matured by this process.—Der Industriöse Geschäftsmann.

Paper for Keeping Articles Moist.—To render paper, parchment, and other fibrous substances soft, pliable, and elastic, capable of absorbing and retaining moisture, also to render them transparent in many cases, these should be treated with a solution of potassium or sodium acetate, grape sugar, dextrine, starch, and other mucilaginous and gelatinous substances may be added according to the purpose for which the paper is intended to be used. The addition of an antiseptic, such as carbolic acid or salicylic acid, is also recommended.—Neueste Erfindungen und Erfahrungen.

To Clean Old Oil Paintings.—Mix 125 parts by weight of ox gall, the same quantity of vinegar, 250 parts ammonia, and 32 of salt, and allow the mixture to stand for 24 hours in a closed and tied-up pot till the salt is dissolved; then stir and brush the pictures well with a soft brush dipped in the solution. Then place the pictures in a slanting position, rinse them off at once with cold water, and when dry apply varnish. Old oil paintings may also be cleaned by rubbing them carefully with a small sponge dipped in a solution of soap. They should then be rinsed several times with cold water, dried in the open air and provided with a fresh coat of varnish.

To Loosen Glass Stoppers.—When glass stoppers cannot be removed from bottles or glasses, pour a few drops of sweet oil around them and then, with a key, engaging the stopper with the bow, endeavor to turn it around. If this is unsuccessful, stand the bottle near the stove, not on a very hot part of the stove, so that it may be gradually heated. After a while, try, by tapping lightly on the stopper, whether it cannot be loosened. Should this not be the case, the process, as above described, will have to be repeated three or four times, after which the stopper will be loosened without fail. In cases of other fast stoppers, where the contents of the bottle are of slight importance, drop a few drops of petroleum on them and let them stand a few moments.

To Smoke Eels or Salmon.—To smoke eels or salmon, salt them with ordinary salt and a little niter and keep them for four days in the brine. Then take a large cask, as high a one as possible, remove the bottom, bore a number of holes at the top and through the staves, and rest it upon stones rather more than a foot high, so that there is an empty space beneath. Now suspend the eels or salmon, previously fastened to thin sticks, in the cask and light under them a choked fire of birch or oak leaves, juniper twigs, and juniper berries and allow them to remain therein for three days. It is important that the fire should not be allowed to burst into flame and that an abundant quantity of smoke should be produced. To be considered good, smoked eels and salmon should have a nice golden yellow color on the outside and a fresh red color like raw ham, on the inside. They should also have a pleasant smell.—Der Industriöse Geschäftsmann.

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